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PRACTICAL PREVENTIVE MEDICINE

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TO MY PARENTS

FOREWORD

THE following pages represent an endeavor to briefly present the salient features of modern preventive medicine. In a desire to cover the entire field, a great condensation has been effected, which in many instances perhaps results in an inadequate consideration of important subjects. It is believed this represents the minimum knowledge of the subject which a student of medicine or a practitioner of medicine should be expected to possess.

While admittedly brief, the student or reader desiring a broader knowledge will be assisted by the numerous references given. These have been particularly designed to introduce the student to the vast stores of public health literature which exist in the publications of various departments of the United States government. Any individual especially interested in this field should make every effort to acquire those listed and keep in touch with the new publications issued.

The medical profession can play an important rôle in the field of preventive medicine and public health. At present physicians are neglecting their opportunities. If this neglect continues the opportunities will lessen and the field will be taken away from physicians by a changing public sentiment. If these pages will bring home to medical students and practitioners a realization of their public health responsibilities and stimulate co-operation with public health authorities, the labor of their preparation will have been abundantly rewarded.

No originality is claimed for the material here presented. All available sources of information have been freely utilized. Special acknowledgement should be made of the utilization of Rosenau's "Preventive Medicine and Hygiene" to which the specialist or advanced student will naturally turn, and to the report of the Committee on Standard Regulations of the American Public Health Association.

MARK F. BOYD.

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PRACTICAL PREVENTIVE MEDICINE

CHAPTER I

INTRODUCTION

Preventive Medicine may be defined as that branch of applied biology which seeks to reduce or eradicate disease by removing or altering the responsible etiological factors. Included within its scope are two subjects which are often confused with it, these are hygiene and sanitation respectively. Hygiene is the proper care of the body to permit the normal functioning of the various organs and tissues, while sanitation is the proper cleanliness of the environment.

Since preventive medicine requires a complete knowledge of the etiology of disease for its application, it is apparent that deficiencies of etiologic knowledge must necessarily limit the scope of successful work. There are however five groups of diseases whose etiology is sufficiently well known to warrant their classification as preventable. The groups are:

(I) Diseases produced as the result of the invasion of the body by micro-organisms;

(II) Diseases the result of a faulty or deficient diet;

(III) Diseases the result of unhygienic or insanitary conditions of employment;

(IV) Diseases arising as the result of the puerperal state; and

(V) Diseases transmitted from parent to offspring.

Despite the fact that the number of diseases included in the above groups is limited, this handicap is very much reduced by the fact that the diseases included in the above groups are for the most part, of considerable importance as causes of morbidity and mortality, so that effective control measures directed against them will accomplish a great deal in reducing the hazards of life. Their importance may be judged from the following mortality statistics from the registration area of the United States:

TABLE I

	1912	1913
Per cent. of total population of U. S. in registration area....	63.2	65.1
Total deaths, all causes....	838,251	890,848
Deaths, disease of group 1....	287,645	304,580
Deaths, disease of group 2....	4,409	15,005
Deaths, disease of group 3....	156	171
Deaths, disease of group 4....	9,035	10,010
Deaths, disease of group 5....	Not a direct cause of death.	

While the diseases of group 5 are not of importance as causes of mortality, they nevertheless exert a certain definite influence which we will consider later.

Directly as well as indirectly these diseases are the cause of immense economic losses. These affect both the individual and the social fabric. The following economic losses may be enumerated:

(*a*) Temporary or permanent disablement of the patient as an immediate result of the disease, resulting to the individual in temporary or permanent loss of earning, and to society in the loss of productive labor;

(*b*) Sequelæ or complications which permanently impair the individuals usefulness or hasten death from other causes;

(*c*) Expenses of illness, which if due to preventable illness, must be regarded as an economic loss;

(*d*) The expense incident to the establishment and maintenance of public hospitals, asylums and charitable agencies to relieve want arising from disabling sickness;

(*e*) Making vast regions of the earth's surface uninhabitable for the civilized races; while

(*f*) Preventable diseases of the domesticated food producing animals may cause such inroads into their numbers that animal foods become scarce and consequently high in price. This is due both to a destruction of the animals as well as to a decreased productiveness of those surviving.

With most of the diseases included in the foregoing groups our available knowledge is sufficiently adequate to justify us in classifying them as preventable. Their continued presence with us is chiefly due to the lack of ways and means for placing effective control measures in operation. It may never be practicable to place in operation in civil life the drastic, but nevertheless effective measures which have made the military application of preventive medicine so brilliant, though the experience with military discipline emphasizes the administrative

difficulties which are encountered in the civil application of these measures, where tact rather than force must win the point. Conceiving a population wherein an adequately organized defensive and offensive body was available to apply proper measures, we might expect that their continued application would have certain effects. Among these we may prophesy the following:

(*a*) An increase in the period of expectation of life, that is the probable duration of the life of the hypothetical average individual. This change will be accompanied by the following phenomena: (1) There will first be a gradual diminution in the total death rate, due to the gradual disappearance of the preventable diseases as causes of mortality; (2) A change in the age distribution of the deaths will next be apparent. The majority of the conditions we are considering are most active as causes of death among the ages below thirty. Their elimination will of course permit a larger proportion of individuals to survive to ages beyond thirty, and as the change takes place the number of deaths above thirty will slowly increase, proportionate to the decrease in the deaths below thirty. (3) The conditions which are operative as causes of death at the age periods beyond thirty, other than those of our particular groups will gradually be found to be responsible for an increasingly greater number of deaths. This state of affairs is not necessarily alarming, but rather is encouraging, as indicating that a larger proportion of individuals are permitted to survive to middle life and older periods. This is, in our opinion, the most rational explanation of the increases which have been observed in the mortality from carcinoma and cardio-renal disease. The completion of this cycle of transformation will probably leave us with a crude death rate from all causes very nearly the same as before the days of even the most feeble preventive work. The important difference will be in the age distribution of the deaths. Instead of the many dying young, the majority will survive to middle life or old age. The individual will have a better chance of living what may be said to be a life of "normal" duration.

(*b*) Unhealthful regions of the earth will be made habitable, consequently human overcrowding will be relieved, and more of the earth's treasures will be available for mankind.

(*c*) The economic productiveness of the individual as well as of the race will be increased. As a consequence individual and national wealth will increase and poverty and want diminish.

(*d*) The supply of animal foods will increase and only be limited by the available roughage.

(*e*) Lastly we may prophesy an improvement in the general physical condition of the race.

The effective operation of the necessary machinery to apply the etiological knowledge we shall briefly sketch may be said to be the problem. It is one of great difficulty and complexity and its complete solution is far distant. Partial means to control the diseases of group one are as we shall presently see, of considerable antiquity, and arose from a recognition that persons infected with communicable diseases were a danger to the public. Thus there developed the field of public health. Originally it arose from a purely selfish attitude on the part of society as a whole to protect itself from certain infected individuals, whose objectionable characteristics arose from no fault of their own. To-day we find a changing attitude, a realization that if society requires protection by enforcing certain restrictive measures on individuals innocent of crime, justice demands that these persons receive consideration. In addition the field of public health has recently come to have a broader scope, due to the realization that many of our problems, if not all, have a sociological foundation, and that a divorce is not always possible. Relief will only be secured when these associated problems are solved.

In a general way our problem of disease prevention has two aspects, namely curative and prophylactic.

The curative aspect is primarily the problem of the practicing physician and when effectively solved will be manifested by a lowered case-mortality. The physician will be assisted in its solution by the development of methods and the provision of facilities for the making of prompt diagnoses and the development and application of specific therapeutic measures. This aspect is clearly a problem of the practicing physician in his relation to the individual requiring his services.

On the other hand the prophylactic aspect can only give satisfactory results when an entire social unit, such as any community, takes cognizance of its problem and attacks it with all the resources at its collective command. For this purpose our social and political units have delegated power and authority to certain officials for the protection of the public health. The problem confronting the officials relates particularly to a reduction in the number of cases of preventable diseases in the population under their care. They are not professionally interested in disease from the individualistic standpoint of the physician. The degree of success achieved by

these officials will be directly in proportion to the degree in which they educate their public in the principles they are trying to apply. Without the co-operation of the medical profession and the laity health authorities will accomplish very little effective work.

In general the field of public health work may be said to have the following scope:

(*a*) Improved personal hygiene of all individuals, including better standards of personal cleanliness, better dietaries, reasonable working hours, recreation and adequate clothing.

(*b*) Improved standards of domestic and public sanitation, including relief from overcrowding, proper illumination, heating and ventilation, water supply, excreta disposal, etc.

(*c*) Improved sanitation of places of employment.

(*d*) The immunization of susceptible persons and the control of infected persons.

(*e*) The improvement of the breeding stock of the human race by the elimination of the physically and mentally unfit from reproduction.

(*f*) The provision of facilities for aiding physicians in the diagnosis and care of their patients, *i.e.*, laboratories, hospitals and clinics.

Landmarks in the Development of Preventive Medicine.—The only practices of the ancients which we at this day may consider to be preventive measures based upon a firm, rational foundation as we understand the subject, are found described in the Mosaic law. All other practices of the ancients designed to prevent diseases are clearly allied with religion and superstition, and hence were of little importance and no value. Therefore the Mosaic instructions when interpreted in the light of present day knowledge have an immense importance. These practices however do not seem to have been copied by contemporaneous Gentile races.

Aside from the foregoing the earliest public health practice which has survived to the present day is maritime quarantine, which was developed by the mediæval Italian cities of Venice and Genoa when at the height of their commercial splendor, as a protection against the introduction of plague from oriental ports. At this time the ideas of disease transmission were very vague, but a suspicion of the transmissibility of some seems to have existed. A little later, in 1546, Geronimo Fracastorius published in Venice a work entitled "De contagionibus et contagiosis morbis et curatione" in which was first definitely ad-

vanced the doctrine of contagion. He divided infections into three classes: (1) Those infecting by immediate contact, (2) Those infecting through intermediate agents, such as fomites and (3) Those infecting at a distance or through the air In 1659 Kircher, and in 1675 van Leeuwenhoek first observed and described living organisms too small to be seen by the naked eye. Kircher in 1671 suggested that various infections were the result of the activity of these minute organisms. Kircher's views were received with scepticism by his contemporaries, and later, in 1762, Plenciz of Vienna again advanced the same views. These theories however did not gain headway until the following century, when they were demonstrated scientifically.

The first attempt at artificial active immunization among European nations must be credited to Lady Mary Wortley Montague, who from 1717 to 1721 introduced into England from Constantinople, the process of variolation as a protection against smallpox. This was an event whose importance has been overshadowed by the employment of an attenuated virus for the same purpose by Jenner. His discovery was first published in 1798.

In 1843, Oliver Wendell Holmes, an American physician and author of note, first called attention to the contagiousness of puerperal fever. The activity of water as a route for the transfer for infective agents was first recognized in 1854 by Dr. Snow in connection with the famous Broad Street well cholera outbreak. Three years later, Dr. Taylor recognized the similar activity of milk in an outbreak of typhoid at Penrith. The first scientific demonstration of the transmissible character of an infectious disease was performed by Villemin with tuberculosis in 1865, while the first demonstration of the etiological relation of micro-parasites to disease was accomplished by Pasteur in the case of anthrax in 1876, thus substantiating the earlier beliefs of Kircher and Plenciz. Patrick Manson recognized the first known insect transmitted disease, when he found that mosquitoes transmit *Filaria bancrofti*.

From the time of Jenner no progress in artificial immunization was made until Pasteur demonstrated the protective power of his anthrax vaccine on sheep in 1881, and in 1885 extended the same principle to the treatment of rabies.

In 1893, Smith and Kilbourne, two Americans, discovered he cause and means of transmission of the first known insect ansmitted protozoal disease, namely Texas fever of cattle. The importance of carriers in the perpetuation of typhoid

fever was first recognized by Robert Koch, who called attention to them in 1902. Carriers of the diphtheria bacillus had been observed before this, but their importance was not recognized.

The results which can accompany the application of the principles of preventive medicine received their first great popular demonstration by Gorgas, when he eradicated yellow fever and malaria from Havana and the Canal Zone. This accomplishment may be considered to mark the beginning of active public interest in the possibilities of preventive medicine, a situation which may be said to characterize the present day.

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SECTION I

DISEASES DUE TO INVADING MICRO-ORGANISMS: EPIDEMIOLOGY

CHAPTER II

SOURCES OF INFECTION

1. As a result of the invasion of a population by a given species of pathogenic micro-organisms certain phenomena are produced, some of which are of present interest, particularly those dealing with the incidence or prevalence of disease. This constitutes the field of epidemiology, which may be defined as the science treating of the sources and routes of infection and their activities, as manifested by the incidence or prevalence of an infectious disease in a given population.

2. Before proceeding further certain fundamental definitions had best be presented:

(*a*) An *infectious disease* is produced as the result of the invasion of the tissues of an animal or plant by a living organism. Because the invading organism may be in many instances transferred from individual to individual of the host species, these diseases are perhaps more aptly termed *communicable.* Those communicable diseases which are transmitted exclusively or nearly so, directly from host to host are spoken of as *contagious*, or popularly as "*catching.*"

(*b*) Following the invasion of the host by an organism capable of producing disease, a variable period elapses before the characteristic symptoms are manifested and during which the ordinary health is apparently maintained. This period is the *incubation period.* With some infections, as small pox and measles, its length is very constant, with others such as typhoid, it is subject to considerable variation. Its duration is probably dependent upon the number and virulence of the invading organisms on the one hand, and to the specific degree of the host's resistance on the other.

(*c*) A *primary case* of a communicable disease is the first case arising within a given area, which is the ascribed source

of the infective agents transferred to other individuals who later develop the same infection.

A *secondary case* of a communicable disease arises as a result of infection received from a pre-existing known case, with which it has been associated. Both are relative terms.

A *vector* is any intermediate object which serves to transfer infective agents from one host to another. The use of this term is commonly restricted to those insects which occupy this position.

An *epidemic* is the occurrence within a *limited time* among a *limited population*, of an unusual number of cases of communicable disease.

A *pandemic* is similar to an epidemic, except the population concerned is much larger, that of an entire continent or the world.

Endemic refers to the usual prevalence of a communicable disease among a *limited population.*

Epizootic is a term analagous to epidemic, referring to the diseases of lower animals.

3. **Sources of Infection.**—As a result of extensive bacteriologic researches as well as epidemiologic studies of similar magnitude, performed by scientific observers everywhere it may be stated as axiomatic that:

All communicable diseases arise from the invasion of a susceptible host by organisms derived from a pre-existing invaded host. The pre-existing invaded host is known as the *source* of *infection.*

It has long been observed as a fairly constant characteristic that a greater incidence of these diseases was found among individuals in contact with those sick with the same disease, although many cases certainly occur that do not present such a history. At one time in the early days of bacteriologic science it was believed that patients had received infection from organisms that had developed in, and were received from a patient's environment. In other words, the invaders were saprophytes which incidentally possessed pathogenic powers. Such is apparently the actual case with some of the pathogenic fungi. On the other hand, the pathogenic bacteria are apparently of a highly parasitic nature. Bacteriological researches have failed to demonstrate that they can live a sustained vegetative extracorporeal existence. When found without the body it is under circumstances which indicate they are existing within a definite radius surrounding an infected

person, and their origin has been undeniably the excretions and secretions of the infected person, and it has been further found that these micro-organisms, with certain few notable exceptions, are only capable of a rather transitory extracorporeal existence, during which period their vital activities are more or less suspended and their vitality tends to decrease.

4. The sources of infection as defined above may be classified as follows:

(*a*) *Typical Cases.*—These are individuals in whom the disease presents the clinical manifestations typical of the disease.

(*b*) *Atypical Cases* (*Abortive or Missed*).—These are individuals in whom the clinical symptoms are indefinite or indistinctive, and as a consequence are difficult to diagnose. Furthermore the illness is usually mild. Bacteriologic assistance is frequently required for a diagnosis, though sometimes, when occurring as secondary cases where the primary case is known, they may be diagnosed clinically. Their proportion to the typical cases varies with different diseases.

(*c*) *Carriers* are apparently healthy persons who are harboring the specific organisms of communicable diseases and discharging them from their bodies. They are encountered in well defined types.

1. Incubatory carriers, *i.e.*, individuals who are actually in the incubation period of a given infectious disease and will shortly manifest the characteristic symptoms.

2. Healthy carriers, *i.e.*, individuals who throughout the entire period of their harborage never present clinical manifestations that may be referable to their parasitism.

3. Convalescent carriers, *i.e.*, individuals who have recovered from an attack of the disease in question, but who continue to harbor the specific infective agents. According to the duration of their infectivity, convalescent carriers are commonly arbitrarily divided into two groups:

(*a*) Temporary carriers, whose infectivity subsides in three months following the development of their convalescence, and

(*b*) Chronic carriers, in whom the infective agents persist for periods longer than three months.

It must be remembered that the healthy and convalescent carriers possess an active resistance to the micro-organisms they are harboring, so that while they themselves are protected they endanger their associates.

The proportion of carriers to cases at any given time with a given disease is subject to wide fluctuations and is difficult of

accurate estimation. The carrier condition, in so far as it relates to the actual discharge of micro-organism is intermittent. The particular secretions or excretions are not continuously infective, even though the micro-organisms are continually present in the body. In this respect the carrier condition is closely related to the group of sources known as latent cases.

(*d*) *Latent Cases.*—With certain infections the active clinical manifestations tend to spontaneously subside, though the micro-organisms themselves persist, apparently in a latent condition, for long and variable periods of time, later to renew their activity when from some intercurrent cause their host's resistance is reduced. During the period of their latency they are not discharged from the body. Latent infection, for example, is observed in syphilis, tuberculosis and glanders.

(*e*) *Lower Animals as Sources of Infection.*—The foregoing observations relate particularly to the so-called diseases of man, for which human beings serve solely as sources of dissemination. On the other hand, a certain group of human infections, such as rabies, glanders, anthrax, etc., are not due to agents derived from infected human beings, but from infected animals, though the role for the animal as a source of infection is closely parallel.

5. **Examples of disease classification** in the foregoing types:

(*a*) Atypical forms are encountered in the following infections:

Typhoid fever	Poliomyelitis
Septic sore throat	Typhus Fever
Measles	Diphtheria
Asiatic cholera	Small pox
Meningococcus meningitis	Yellow fever
Scarlet fever	

(*b*) Incubatory carriers have been observed in the following:

Typhoid Fever	Whooping cough
Paratyphoid Fever	Measles
Malta Fever	Small pox
Dysentery (amœbic)	Anthrax
Diphtheria	

(*c*) Healthy carriers of micro-organisms producing the following diseases have been observed:

Typhoid Fever	Pneumonia
Paratyphoid Fever	Meningococcus meningitis
Dysentery (amœbic and bacillary)	Gonorrhœa
	Plague

Cholera	Poliomyelitis
Diphtheria	Malaria
Scarlet Fever	

(*d*) Convalescent carriers of the following:

Typhoid Fever	Dysentery (bacillary and amœbic)
Paratyphoid Fever	Cholera
Diphtheria	Meningococcus meningitis
Pneumonia	African Sleeping Sickness
Poliomyelitis	

6. **Exit of Micro-organisms** from the Body of Infected Persons.

Different species of micro-organisms have adapted themselves to different pathways of exit from the body of infected persons. In order that the propagation of the species be maintained, it is of course necessary that colonizing individuals be disseminated. For the most part the adaptation is to the natural avenues of exit used for the physiological discharge of surplus secretions or the excretions of the body. To a considerable extent the adaptation is specific, *i.e.*, certain of these pathways are more certain to contain micro-organisms producing a given disease, than others. For example the following discharges are the means of exit of the infective agents producing:

(*a*) Feces: Typhoid, dysentery, cholera, etc.
(*b*) Urine: Typhoid, etc.
(*c*) Sputum: Tuberculosis, pneumonia, etc.
(*d*) Saliva: Rabies.
(*e*) Nasopharyngeal secretions: Diphtheria, cerebro-spinal meningitis, etc.
(*f*) Sweat: Typhoid.
(*g*) Milk: Typhoid, Malta fever, tuberculosis.
(*h*) Epithelial desquamations: Small pox.
(*i*) Purulent discharges: Scarlet Fever.
(*j*) Blood: Malaria, African sleeping sickness.
(*k*) Lachrymal secretion: Conjunctivitis.
(*l*) Placental circulation: Syphilis, tuberculosis.

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CHAPTER III

THE DISSEMINATION OF INFECTIVE AGENTS

1. **Stage of Disease in Relation to Dissemination.**—(*a*) *Stage of Invasion and Incipiency.*—With some diseases such as tuberculosis, when the micro-organisms are in deep-seated lesions not in contact with passage ways to the exterior, the infected person is of little or no active danger to others as a source of infection. On the other hand, with diseases such as diphtheria, where the micro-organisms are in superficial situations having ready access to the exterior, this period is of great importance.

(*b*) *Non-infective Stages of Active Disease.*—When syphilitic infection progresses to the tertiary and para-syphilitic stages, these as long as they persist are non-infectious. On the other hand, they partake of the character of latent infections, inasmuch as relapses to lesions of the secondary type may occur.

2. **Portals Through Which Infective Agents Enter the Body.**—Different infective agents have adapted themselves to varying portals of entrance into the body and for the most part, if *introduced by a route other than the* one to which adapted, fail to gain a foothold. The principal body orifices again play an important part, *particularly* the orifices of entrance, rather than those of exit. After having passed the threshold of this portal, the infective agents may proceed by divergent pathways to penetrate the physiological interior of the body.

The mouth and the nose are portals of entrance of greatest importance from the standpoint of the number of infective agents which are introduced through them.

After passing this threshold, some, as the typhoid bacillus may go onward to the intestinal tract, others as the pneumococcus procede to the respiratory passages, while others as the diphtheria bacillus, will remain near the point of their entry in the naso-pharynx.

Areas of specialized epithelium, as for example that of the conjunctiva or genitalia, are particularly well suited to some infective agents.

Others, by various means, usually due to some form of traumatism, (inoculation) directly penetrate the outer epithelium of the body to the subcutaneous tissues, and thence gain access to the circulation or to the central nervous system.

3. **Dosage.**—The mere introduction of a given infective agent into the body will not necessarily mean that the microorganisms will succeed in gaining a foot-hold. The success of a given transfer will vary directly with the number and virulence of the organisms transferred, and indirectly with the resistance of the individual invaded. These factors also influence the duration of the period of incubation.

4. **The Extracorporeal Existence of Infective Agents.**—The infective agents are for the most part highly specialized parasites that require for their existence the conditions of temperature, humidity, moisture, and nutrition that they encounter within the body of their host. When these conditions are not available their vegetative and reproductive activities become sluggish, and if prolonged the vitality of the organism may become impaired. Furthermore the colonizing individuals when expelled from the body of their host are ordinarily immediately exposed to the action of the natural germicidal agencies, sunlight and desiccation. (See Table II.) In consequence of these factors they become rapidly attenuated and are soon

TABLE II

Resistance to Sunlight and Desiccation of certain non-spore forming Bacteria. (Compiled from various authorities)

Organism	Sunlight direct	Material	Authority
Sp. pallida..........	Diffuse—11½ hrs.	Cultures	Zinsser
Gonococcus			
Pneumococcus.......	1 hr.		Hiss & Zinsser
Meningococcus......	Less than 24 hrs.		Hiss & Zinsser
B. mallei...........	24 hrs.		Hiss & Zinsser
Cholera vibrio			
B. pestis............	4–5 hrs.		Hiss & Zinsser
B. diphtheriæ........	6 min.	film culture	Briscoe
B. typhosus..........	9–26 hrs.	fabric	Sternberg
	2 min.	fabric	Briscoe
B. tuberculosis.......	2 min.	fabric	Briscoe
	45 hrs.	sputum	Mitchell & Crouch
M. melitensis.......			

Organism	Desiccation	Material	Authority	Notes
Sp. pallida	1 hr.	Films	Zinsser	
Gonococcus	18–24 hrs.	Pus on fabrics	Hiss & Zinsser	
Pneumococcus	1–4 mo. no light		Hiss & Zinsser	In fine spray sputum, ½ hrs., ordinary light and temperature-Wood.
Meningococcus	3 hrs.–20°C.		Besson	
B. mallei	48 hrs.–room temp.	Pus, thin layer	Besson	
Cholera vibrio	1 min.	Film	Strong	Dry atmosphere, 6 min., spray wet atmosphere 30 min. in spray. Strong.
B. pestis	5 min.	Film	Strong	Floors—24–48 hrs. Adv. Comm. India.
B. diphtheriæ	5 days	Film	Briscoe	Desiccated in membrane—4 mos. still virulent Park & Williams.
B. typhosus	5 days	Film	Briscoe	
B. tuberculosis	8 days	Film	Briscoe	
	2 mos.	Sputum	Hiss & Zinsser	
M. melitensis	13–28 days	Dust	Med. Fever Com.	
	7–37 days	Fabric & Urine	Med. Fever Com.	

NOTE: Results refer to action of the full physical force concerned.

destroyed. It is exceedingly rare for them to gain introduction into any medium favorable for multiplication, such as milk. The fortunate individuals who do succeed in reaching a new host are but a small fraction of those which left the source. These circumstances are our salvation.

It must of course be remembered that the spore-forming bacteria such as the anthrax and tetanus bacilli, are exceptions to the rule in so far as survival is concerned, but on the other hand, their numbers probably do not increase during this period.

Exception must also be made to certain animal infective agents. These which have a definitive host of course multiply in that species. A few of the multicellular parasites require an extracorporeal period to complete certain stages of their life cycle and are particularly adapted to this. Their degree of

specialization as parasites is not as extreme as it is with the parasitic bacteria.

Therefore as a general rule, ***the closer the relationship in time and space with the source of infection, the greater is the chance or the successful transfer of unattenuated infective agents.***

5. **Routes of Transference.**—The successful transfer of infective agents from host to host is a lottery in which all the chances are against the individual micro-organisms. The perpetuation of the species is secured by the discharge of tremendously enormous numbers of individuals from the infected source.

Their transfer is effected by means which serve unconsciously to carry human secretions from one person to another. These means may be classified into the following groups in order of their importance. They are:

(*a*) Contact
(*b*) Foods, including
    Water and Ice.
    Milk and Dairy Products.
    Meat and Shell fish.
    Other Foods.
(*c*) Insects
    Mechanical transmission.
    Biological transmission.
(*d*) Soil.
(*e*) Fomites.

By the later term we understand objects upon which infective agents may retain their vitality for prolonged periods of time. As a matter of fact, this means of transmission is closely related to certain forms of contact and is only of importance with the spore-forming infective agents.

CHAPTER IV

CONTACT TRANSMISSION

1. By contact transmission we mean the transfer of infective secretions or excretions from one person to another with the lapse of but a short space of time during which interval the infective agents are subject to little or no attenuation. From the great variety of infective agents transmitted by this means, as well as the constancy with which opportunities for this transference are encountered, it is the most important of the routes of infection.

2. **Means of Contact Transference.**—Briefly we may say that contact transmission is accomplished through the continous universal commerce in the body secretions and excretions. This commerce is accomplished by the following agencies.

(*a*) *Mouth Spray or Droplet Infection.*—Every person in talking, coughing, or sneezing, emits from the mouth with more or less explosive force a fine spray of saliva, which will of course contain suspended in it, micro-organisms from the mouth, nasopharynx, or respiratory passages. These particles remain suspended in the air for some time by reason of their buoyancy, but tend to settle out. Air currents may distribute them for short distances. They will of course ultimately evaporate and with evaporation, desiccation of the micro-organisms will occur. The survival of the droplets will of course be longer in a cold humid atmosphere than in a warm dry atmosphere. In a more or less stagnant atmosphere, a quiescent individual may cover a radius of about six feet with these droplets. These are probably of greatest importance when expelled directly onto the body surface of another individual, although the buoyant particles are undoubtedly responsible for the old belief in airborne infection.

(*b*) *Hands and Fingers contaminated with Secretions* are undoubtedly the most important agencies in contact infection. Their importance is both from the standpoint of distribution and collection. Fingers are naturally exploratory in their habits, reaching all portions of the body surface and the body

orifices of their owner, thus becoming contaminated with the secretions and excretions, and transferring these to objects later handled.

In turn from such objects, the infective secretions of other persons similarly distributed, are collected and introduced into or onto the body of their owner. The fingers of a non-infected person may also transfer infective agents to a third person. It is for this reason that the habits of avoiding the unnecessary introduction of the fingers into the mouth and nose, as well as the habit of washing the hands before eating, are of paramount hygienic importance.

(*c*) A certain communism in small objects was formerly very popular, but fortunately today is looked upon with little esteem. This was the practice of furnishing common articles in public places for intimate personal service, such as drinking cups, towels, combs, pencils and numerous other objects. The intimate use to which these are put renders their contamination by excretions and secretions practically unavoidable, which will be effectively transferred to the next person using them. Despite the reduction in recent years of objects, such as drinking cups, which are directly contaminated with secretions, it is practically impossible to always avoid objects which are continually contaminated with human secretions.

(*d*) Lastly, direct approximation of the body surfaces of two different individuals, such as that which occurs during a hand clasp, kissing or sexual intercourse, will effectively transmit infective agents present on one to the other, under circumstances which of course are altogether favorable to the infective agents.

The term direct contact transmission is applied to the second and the last of these agencies, as well as to certain aspects of the first. In these of course, no intermediate objects participate in the transfer. Distinction between indirect contact transmission and fomites transmission has already been made.

3. **Importance of Contact Transmission with Different Infective Agents.**—According to the importance of contact in the transmission of different infective agents, we can distinguish several groups of diseases.

(*a*) *Diseases Transmitted Solely by Direct Contact.*—This group includes the venereal diseases, syphilis and gonorrhœa, which from a practical standpoint are propagated nearly exclusively by sexual intercourse. Under these circumstances fresh highly infective secretions are transferred.

(*b*) *Diseases Usually Transmitted by Contact.*—This group includes the common so-called "contagious" diseases, for example, small pox, chicken pox, mumps, whooping cough, measles, diphtheria, scarlet fever, common colds, influenza, tuberculosis, meningitis, pneumonia, poliomyelitis, etc. It is known that several of these may be transmitted by other routes of infection, but with all contact transmission is the principle means by which the infective agents are distributed.

(*c*) *Diseases Frequently Transmitted by Contact.*—With these contact transmission is quite common and is of far greater importance in the propagation of their infective agents than is generally recognized. The spectacular, explosive outbreaks due to the occasional activity of other routes of infection have overshadowed the quiet unpretentious activity of contact in the continued propagation of their infective agents. To this group belong typhoid fever, Asiatic cholera and dysentery (Fig. 3).

4. It is to be noted in the foregoing classification that the varying importance of contact transmission is clearly associated with the route of exit from the body to which different species of infective agents are adapted. As we shall endeavor to show, this naturally influences the distribution of the infective agents.

In the first of the foregoing groups, namely the venereal diseases, the active lesions are ordinarily present on concealed portions of the body, on areas covered by the clothing which tend to prevent the very general distribution of infective secretions. Transfer of the infective secretions comes as the result of an act, usually voluntary, which places two individuals in such relationship that transfer of the infective secretions is rendered not only possible but probable.

In the second of the above groups it will be later learned that the most unusual avenue of exit selected by these micro-organisms, at least the predominating avenue, is that offered by the secretions and excretions leaving by the mouth and nose. The physiological structure of this region is such that these secretions do not accumulate until of considerable volume, but rather the accumulations are small and are expelled at frequent intervals. Furthermore these orifices are not covered by artificial devices, so there is no impediment to the frequent expulsion of these secretions, neither do any motives of modesty or artificial impediments prevent the introduction of the fingers into either the mouth or the nose. As a consequence these secretions are distributed thinly over a radius corresponding to the daily movements of their producer.

In the third group the infective agents chiefly leave the body in either the feces or the urine, or both. These excretions are not expelled continuously but accumulate until the capacity of either the rectum or bladder is reached; thereupon they are expelled. Furthermore, from considerations of modesty these orifices are protected by the clothing, which reduces the frequency of finger contamination with these excretions, as well as the frequency with which these discharges are voided. As a consequence these excretions are distributed thickly but irregularly over a relatively small radius.

5. **Importance of the Different Types of Sources of Infection in Contact Transmission.**—The known cases are usually of minor importance in the propagation of these diseases for several reasons. As a result of the invasion they feel ill, consult a physician who usually recognizes the infective character of their illness and directs that a more or less effective regimen of isolation be observed. Even in the absence of a physician, the severity of their illness will tend to restrict their movements or the radius of their activities, and hence temporarily reduce the number of their associates. Both of these factors materially reduce the importance of these patients in the further propagation of their infection, unless perchance they become convalescent carriers.

On the other hand the unrecognized infected persons are commonly those who experience little or no inconvenience as a result of the infection. As a consequence the radius of their activities is reduced but little, they rarely consult a physician, their infectivity is seldom recognized and hence no precautionary measures are employed. Their infective secretions are as a consequence scattered over a wide radius. Thus they are of major importance in the propagation of infective agents.

It is therefore apparent the measures of isolation directed against the sources of infection will be successful in inverse proportion to the number of unrecognized infected persons at large in a community.

6. **Features Characteristic of Contact Transmission.**—(*a*) The greater the intimacy of association between human beings, the better and more frequent will be the opportunities for the transfer of infective agents by contact. The incidence of contact disease is commonly in direct proportion to the density of population in a given area.

(*b*) The intimate association of people at home, at school or in different institutions favors the spread of infection by con-

tact. This aspect is closely associated with housing problems, with *over-crowding* and inadequate lighting and ventilation, both of which tend to prolong the vitality of pathogenic micro-organisms outside the body. Fig. 1 illustrates housing conditions intensified by overcrowding, that favor the dissemination of infective agents by contact. Fig. 2 illustrates the definite relation of overcrowding to disease incidence, as influenced through contact transmission in the case of measles. Under these cir-

FIG. 1.—Mexican corral, city of San Antonio. Front view. The death rate from tuberculosis among residents of buildings of this character is 609 per 100,000, over four times that of the registration area. Lack of facilities for the promotion of personal hygiene, as well as gross overcrowding, in dwelling of this character, favor contact transmission. (*From Public Health Reports, April* 23, 1915, *U. S. P. H. S.*)

cumstances it will frequently be possible to observe a primary and secondary relationship between the cases that arise, the primary case of course serving as the local source of infection.

(*c*) It is to be noted that most of the so-called "children's diseases are included in the group, "commonly transmitted by contact." In other words, these diseases are most commonly observed during the period of childhood. Several explanations for this fact may be advanced. First, it may be due to the well nigh universal susceptibility of children as compared with the

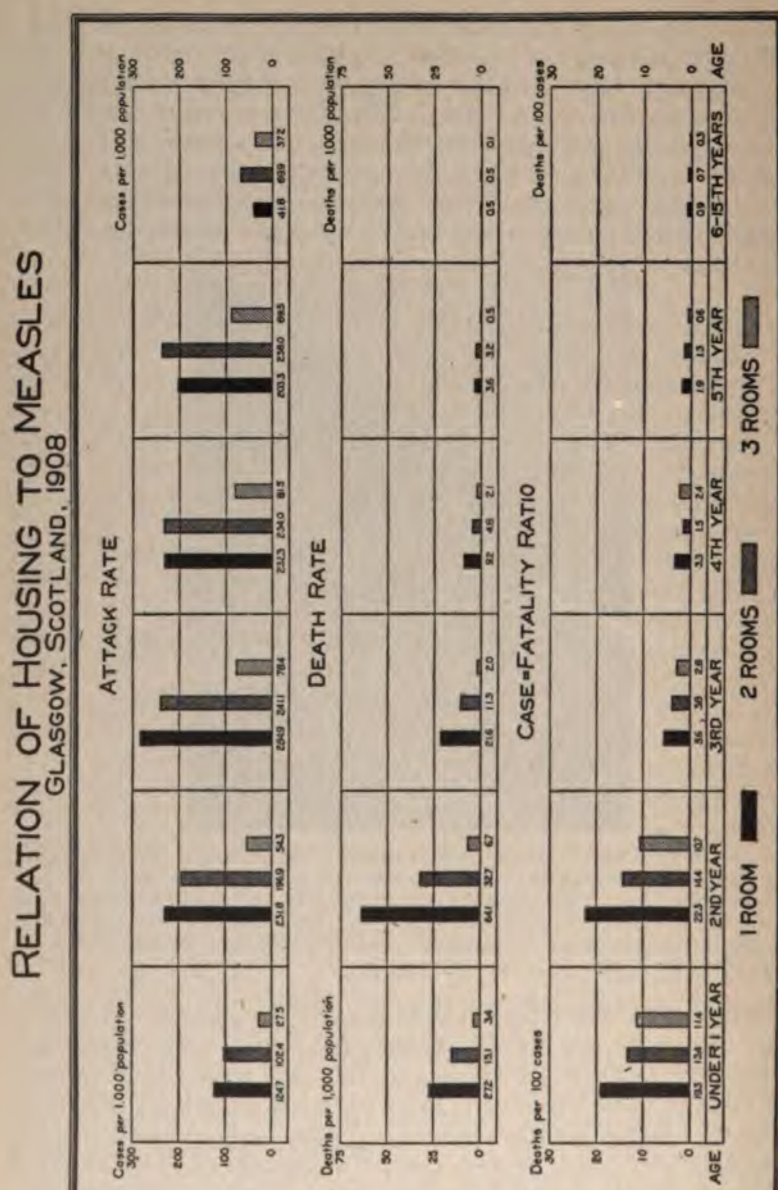

FIG. 2.—(*Statistician's Dep't. The Prudential Insurance Company of America.*)

active acquired immunity possessed by most adults. Or, since it is well recognized that the promiscuous habits of carefree childhood permit greater opportunities in the unrestricted transfer of secretions, it is not improbable that the greater opportunities for contact transfer during this period are of considerable importance in this age incidence.

(*d*) Contact outbreaks or epidemics are never explosive in character, they are always relatively slow spreading, with a gradual rise and decline. This is due to the multitudinous channels through which the infective agents are disseminated, few individuals being simultaneously infected from one source as contrasted with the explosive character of outbreaks follow-

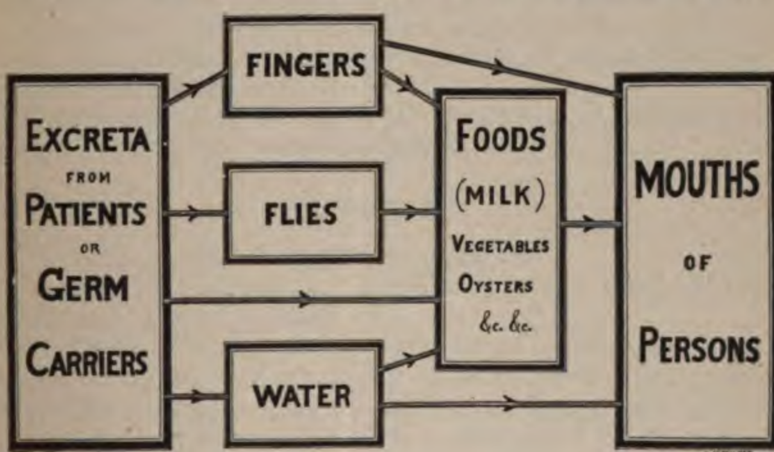

FIG. 3.—Illustrating the participation of several routes of dissemination in the propagation of the typhoid bacillus. (*From U. S. P. H. S.*)

ing the distribution of infected water or food, where a single contaminated vehicle has simultaneously infected a considerable number of persons.

(*e*) Seasonally, contact diseases tend to reach a maximum prevalence during the colder period of the year. At this period the inclement weather forces the human race within doors, where the degree of personal association is more intimate than that during the warmer period when a greater portion of the time can be spent out of doors. This seasonal distribution is also closely associated with the operation of the public schools. It is also to be noted that continued periods of inclement weather, particularly that characterized by excessive cloudiness

is often associated with an increase in the amount of contact transmission, probably by forcing people within doors, as well as by permitting the longer survival of infective agents outside the body, due to the diminished sunlight.

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CHAPTER V

DISEASES TRANSMITTED SOLELY BY CONTACT

1. From the standpoint of practical importance, we have to consider here but two infections, the so-called venereal diseases, syphilis and gonorrhea.

Perhaps in no other infections do we have as forcibly brought to our attention the fact that the questions and problems of preventive medicine are largely of a sociologic nature, since with these diseases dissemination is intimately associated with the problem of promiscuous sexual intercourse and prostitution. One problem cannot be solved effectively without solving the other simultaneously.

Their essential aspects from the standpoint of control and prevention may be presented briefly as follows:

SYPHILIS

(*a*) *Infective Agent.—Treponema pallidum.*

(*b*) *Source of Infection.*—Individuals in the primary and secondary stages of syphilis.

(*c*) *Route of Transmission.*—By direct personal contact, usually venereal, with infected persons, and indirectly by contact with discharges from the lesions, or objects freshly contaminated therewith. Intra-uterine infection of the fetus also occurs, but is of relatively minor importance.

(*d*) *Exit of Infective Agents from Body.*—In purulent or serous discharges from lesions on the skin and mucous membranes.

(*e*) *Incubation Period.*—Usually about three weeks.

(*f*) *Period of Communicability.*—As long as the lesions are open upon the skin or mucous membranes and until the body is free from the infecting organisms as shown by microscopic examinations of material from lesions.

(*g*) *Entrance of Infective Agent into the Body.*—Through minute abrasions in the skin or mucous membranes.

(*h*) **Methods of Control.**—*The Infected Individual.*—1. Diagnosis: By clinical symptoms confirmed by the microscopic examination of the discharges (dark field) and by serum reactions (Wassermann).

2. Isolation: Exclusion from sexual contact and from the preparation or serving of food during the early and active period of the disease, otherwise none unless the patient is unwilling or incapable of observing these precautions.

3. Artificial Immunization: None.

4. Quarantine: None.

5. Concurrent disinfection: Of all infectious discharges and of articles soiled therewith.

6. Terminal Disinfection: None.

General Measures.—1. Education of the laity in matters of sexual hygiene, particularly to the fact that continence in both sexes and at all ages is compatible with health and physical development.

2. Provisions for the accurate and early diagnosis and treatment of venereal patients, in hospitals and dispensaries, with consideration for privacy of the records, and further provision for following patients until they are cured.

3. Repression of prostitution by the use of police power, and control of the use of living premises.

4. Restriction of the sale of alcoholic beverages.

5. Restriction of quack advertisements of services or medicines for the treatment of sex diseases.

6. Abandonment of the use of common towels, cups, toilet articles and eating utensils.

7. Exclusion of persons in the communicable stages of the disease from participation in the preparation and serving of food consumed by others.

8. Personal prophylaxis should be advised to those who expose themselves to the opportunity for infection.

GONORRHEA

(*a*) *Infective Agent.—Micrococcus gonorrheæ.*

(*b*) *Source of Infective Agent.*—Acute or chronic cases or carriers.

(*c*) *Exit of Infective Agent.*—In purulent or serous discharges from inflamed mucous membranes and glands of infected persons, viz., the urethral, vaginal and cervical mucosa; conjunctival mucous membranes, Bartholin's or Skene's glands in the female, and Cowper's and the prostate glands in the male.

(*d*) *Routes of Transmission.*—By direct personal contact, usually venereal, with infected persons and indirectly by contact with articles freshly soiled with the discharges of such persons.

(e) *Incubation Period.*—One to eight days, usually three to five.

(f) *Period of Communicability.*—As long as the gonococcus persists in any of the discharges, whether the infection be an old or recent one.

(g) *Entrance of the Infective Agent into the Body.*—Through areas of specialized epithelium in the genitalia or conjunctiva.

(h) **Methods of Control.**—*The Infected Individual.*—1. Diagnosis: Clinical symptoms confirmed by bacteriological examination.

2. Isolation: When the lesions are in the genito-urinary tract exclusion from sexual contact should be enforced, and when conjunctival, exclusion from school or contact with children as long as the discharges contain the gonococcus.

3. Artificial Immunization: Active immunization with stock or autogenous bacterins is extensively employed therapeutically, but the results secured are not uniform. For obvious reasons they are not employed as a prophylactic.

4. Quarantine: None.

5. Concurrent disinfection: Of discharges from lesions and articles soiled therewith.

6. Terminal Disinfection: None.

General Measures.—1. Same as those enumerated under this heading with syphilis.

2. Use of prophylactic silver solution in the eyes of the new born. (See preventable blindness.)

PREVALENCE OF VENEREAL DISEASES

Existing morbidity and mortality statistics do not give us an accurate idea of the prevalence of these diseases in the United States, neither can some of the estimates published by certain ardent champions of sex hygiene be considered as reliable. The army experience gives probably as accurate an idea as any. Thus according to Vedder, of the new recruits received prior to the recent war, 7.75 per cent. were undoubtedly syphilitic; and 9 per cent. more, probably had syphilis. In the second million of the army raised by draft for the recent war, the incidence of venereal diseases, at the time when received, was 5.4 per 1000 men. (See Fig. 3 *a*.) Among the sailors treated by the Marine Hospital Service it is found that 8.15 per cent. of the annual cases are venereal. As a result of studies upon this question, Banks estimates that 3 per cent. of males

acquire venereal infection annually. The incidence is undoubtedly higher in the American negro. Thus McNeil found

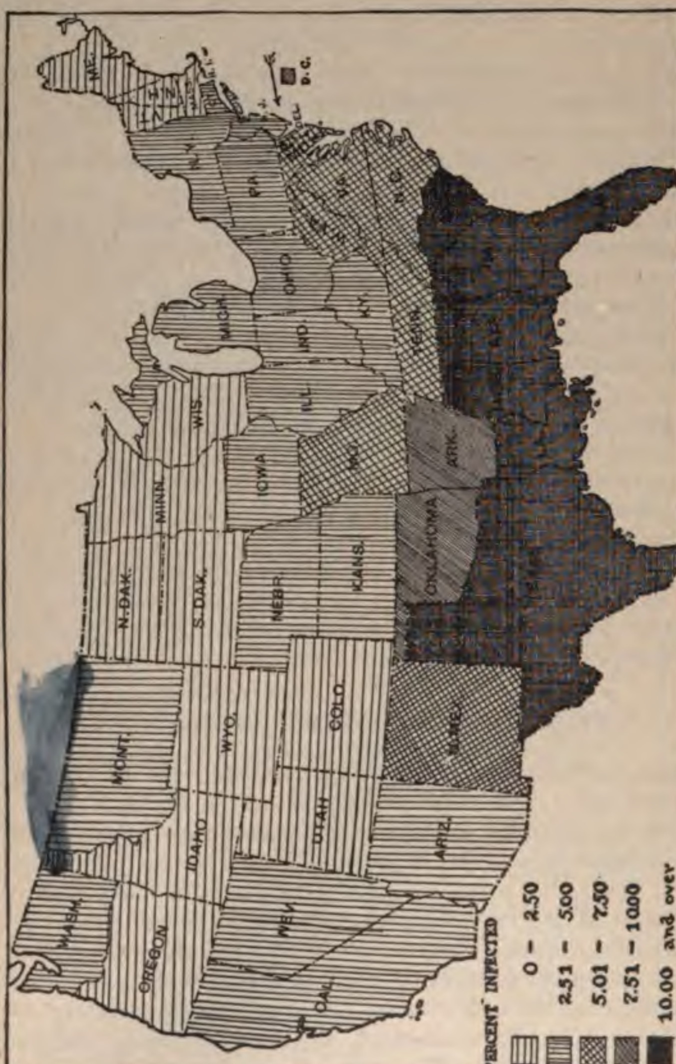

FIG. 4.—The relative standing of the states in respect to the venereal disease rate among the second million men inducted into the army. The darkest states are the states whose drafted men included the highest percentage of venereally diseased men. The lightest states are the states whose draftees included the lowest percentage of venereally diseased men. See legend for exact percentages. (*V. D. Pamphlet No. 30, U. S. P. H. S.*)

in Galveston that between 25 and 30 per cent. of all negroes were syphilitic. The higher incidence of these infections in the

Southern states as shown in Fig. 4, is due to the large proportion of negroes in the population.

STANDARDS FOR THE DISCHARGE OF CARRIERS

The Federal Public Health Service observes the following procedures before discharging venereal patients as non-infectious:

A. Syphilis

The absence of areas on the skin and mucosa from which the infective agent could be discharged.

B. Gonorrhea

1. Males:
   (*a*) Freedom from discharge.
   (*b*) Clear urine without shreds.
   (*c*) Pus expressed from the urethra by prostatic massage must be negative for gonococci on four successive examinations at intervals of one week.
   (*d*) After dilation of the urethra by the passage of a full sized sound, the resulting inflammatory discharge must be negative for gonococci.
2. Females:
   (*a*) No urethral or vaginal discharge.
   (*b*) Two successive negative examinations for gonococci of the secretions of the urethra, vagina, and cervix, with an interval of 48 hours between, and repeated on four successive weeks.

MEDICAL PROPHYLAXIS OF VENEREAL DISEASES

The prompt application of disinfecting substances to the genitalia shortly after intercourse with prostitutes has given excellent results in the army and navy. This method has justly received criticism, inasmuch as it does not tend to encourage continence. The following has been employed for this purpose:

(*a*) Scrub the entire penis with green soap and water.

(*b*) Wash the penis well with 1:2000 bichloride of mercury, paying especial attention to the frenum.

(*c*) Have the patient pass his urine and give an urethral injection of 2 per cent. protargol, which is retained for 1 to 2 minutes.

The following results with this treatment were secured in the U. S. Navy between May 1, 1910 and Aug. 31, 1911.

When applied within 8 hours after exposure, there were 19 infections in 1385 cases, or 1.37 per cent.

When applied within 8 to 12 hours after exposure there were 25 infections in 741 cases, or 3.31 per cent.

When applied within 12 to 24 hours after exposure there were 46 infections in 920 cases, or 5.00 per cent.

PREVENTABLE BLINDNESS

This question can perhaps be best considered at this time, in as much as certain aspects are closely associated with the venereal diseases.

There are approximately 64,000 registered blind in the United States of whom 10 per cent. owe their blindness to ophthalmia neonatorum, while 59 per cent. of the admissions to special schools for the blind owe their handicap to the same infection. Other causes of blindness are the ophthalmias of later life, syphilis, sympathic inflammations, industrial and other accidents, progressive near sightedness, functional disturbances of vision, amaurosis and optic atrophy caused by poisoning from lead, alcohol, tobacco, etc., and wood alcohol.

(*a*) **Ophthalmia neonatorum.**—This term includes all inflammatory conditions of the conjunctiva that occur before the end of the first month of life. Infection usually occurs during the passage of the child through the parturient canal and is derived from the vaginal secretions of the mother, though it may also occur from infection after birth. The gonococcus is the most important single organism in its production, being demonstrated in about 65 per cent. of the cases. This disease is observed in from 6 to 10 of each 1000 births.

It may be effectually prevented by the employment of Crede's method of prophylaxis, which should be always used regardless of the venereal history of the parents. It is as follows: Clean the eyes with a pledget of cotton and boric acid solution. Separate the lids and instill 1 to 2 drops of 1 per cent. silver nitrate solution, which in a few minutes is washed out with saline. In order to encourage this practice many states distribute free outfits of these solutions for the employment of this treatment in all newly born.

(*b*) **Trachoma** is probably not a specific infection, although this is disputed. It is found among those living under defective sanitary conditions, and is extremely chronic. Infection is transmitted by the conjunctival secretions which are disseminated by the fingers, roller towels and handkerchiefs.

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CHAPTER VI

DISEASES USUALLY TRANSMITTED BY CONTACT

This group includes the diseases whose infective agents are most commonly propagated by secretions leaving by the mouth and nose, and for number exceed in importance the other groups. Thus we have to consider by reason of this importance. the following:

Chicken Pox	Diphtheria
German Measles	Influenza
Measles	Leprosy
Mumps	Pneumonia (acute lobar)
Poliomyelitis	Scarlet Fever
Septic Sore Throat	Small Pox
Tuberculosis (pulmonary)	Whooping Cough.
Cerebrospinal Meningitis	

SMALL-POX

(*a*) *Infective Agent.*—Unknown, but it is a filterable virus.

(*b*) *Source of Infection.*—Typical or atypical cases in the active or prodromal stages.

(*c*) *Exit of Infective Agent.*—In the secretions of the mouth and nose (possibly the feces and urine) and discharges from the lesions.

(*d*) *Routes of Transmission.*—By direct or indirect personal contact, and possibly by flies.

(*e*) *Incubation Period.*—Ordinarily 12 to 14 days, sometimes 21.

(*f*) *Period of Communicability.*—From the first appearance of symptoms until the disappearence of all scabs and crusts.

(*g*) *Entrance of Infective Agent into the Body.*—Probably through the nose.

(*h*) **Methods of Control.**—*The Infected Individual.*—1. Diagnosis: By the clinical manifestations. Differentiation of atypical cases from chicken-pox may be achieved by the Tieche test.

2. Isolation: Hospital isolation in screened wards is preferable, continued until the period of communicability is over.

3. Immunization of contacts: By vaccination. There is no means of employing passive immunization.

4. Quarantine: Segregation of all exposed persons for 21 days from the date of last exposure, or until protected by vaccination.

5. Concurrent disinfection: Of all discharges and articles soiled therewith.

6. Terminal disinfection: Thorough cleaning and disinfection of the premises.

General Measures.—1. General vaccination of all persons in infancy, revaccination on entering school, and of the entire population when the disease is prevalent.

Small-pox Vaccination.—(*a*) The importance of this means of protection, as well as the possibility of serious or untoward results from its application, demand its consideration in some detail.

(*b*) Glycerinated virus, put up for distribution in capillary tubes and which has been stored in a refrigerator, should only be employed. One should be sure the date of expiration has not passed, as it is exceedingly important to use fresh, potent virus.

(*c*) Select for vaccination the left arm at the insertion of the deltoid. Cleanse the arm thoroughly by rubbing with green soap, wash with water, and follow with alcohol. Allow the skin to dry. With a flamed needle make three parallel scratches about 1 to ½ inches long and ¾ inch apart, taking care not to draw blood. Expel the contents of vaccine tube on the two outer scratches and with shaft of the needle rub the virus well into scratches. Allow to dry for 10 to 15 minutes. Upon appearance of the eruption it may be covered with a sterile dry dressing.

(*d*) **Course of Eruption in a Primary Take.**—(*a*) *Period of Incubation.*—This is from 3 to 4 days duration. The inoculation scratches will have entirely healed in two or three days.

(*b*) *Period of Papule.*—Along the site of the inoculation scratches one or more small, round, flat, bright red and superficial papules make their appearance. These may be confluent.

(*c*) *Period of Vesicle.*—On the fifth day a small clear vesicle will appear in the center of each of the papules. The area around the vesicles becomes red and swollen and enlarges as the vesicle enlarges. The vesicle is multilocular and umbilicated. It is mature by the eighth day.

(*d*) *Period of the Pustule.*—By the ninth day the center of the vesicle becomes pustular, the skin is swollen, hot, and feverish, and the axillary glands are enlarged. The areola commences to fade by the ninth day.

(*e*) *Period of Scabbing.*—By the 11th to 12th day the pustules begin to dessicate and form a scab, which falls off after 2 to 3 weeks, leaving a red scar, which later turns white.

(*e*) The general symptoms are most noticeable during the stage of pustulation. One may observe malaise, loss of appetite, nausea and vomiting, headache and muscular pain, with 1 to 2 degrees of fever, which lasts from 3 to 7 days.

Immunity appears on the eighth day, and lasts on the average approximately seven years. The best time to vaccinate for the first time is in the first year of life before the second summer.

(*f*) *Re-vaccination* may:

(*a*) Run a course resembling the primary take. In this event the cow-pox immunity has disappeared, or,

(*b*) Run a slightly more rapid course (Accelerated Reaction). The incubation period is short and pustulation occurs by the sixth day, or,

(*c*) With an incubation period of 24 hours or less, an immediate reaction, which presents a small papule or erythema that later fades, may occur in immune persons.

(*g*) *Vaccination of Exposed Persons.*—(*a*) If done during or immediately before the primary fever of small-pox it does not influence the disease nor does it take.

(*b*) If done in the last stages of the small-pox incubation period it takes, but the two infections run a simultaneous course without influencing each other.

(*c*) If done during the 6th to 8th day of incubation, so that its eruption is mature before the onset of small-pox, it will prevent or abort the disease.

Individuals in whom the vaccination immunity is waning may contract small-pox, but the disease will run a very mild course (varioloid).

CHICKEN-POX

This disease is of very little importance itself but great difficulties arise from the fact that mild discrete small-pox may be mistaken for it.

(*a*) *Infective Agent.*—Is unknown but is thought to be a filter passer.

(*b*) *Source of Infection.*—Typical cases or atypical cases in the active or prodromal period.

(*c*) *Exit of Infective Agent.*—In the discharges from lesions on the skin and mucosa, and as a consequence of the latter the buccal and nasopharyngeal secretions are probably infective.

(*d*) *Route of Transmission.*—By direct or indirect contact.

(*e*) *Incubation Period.*—Two to three weeks.

(*f*) *Period of Communicability.*—Until the primary scabs have disappeared from the mucous membranes and the skin.

(*g*) *Entrance of Infective Agent into the Body.*—Probably by the mouth and nose.

(*h*) **Methods of Control.**—*The Infected Individual.*—1. Diagnosis: Based upon clinical manifestations. The Tieche sensitization test for differentiation from small pox is very valuable. The differentiation of chicken-pox from small-pox is of especial importance in those over 15 years of age.

2. Isolation: Exclusion of the patient from school and prevention of his contact with susceptibles.

3. Artificial immunization: Not available.

4. Quarantine: Not required.

5. Concurrent disinfection: Of articles soiled by discharges from the lesions and the bucco-nasal secretions.

6. Terminal disinfection: Thorough cleaning.

General measures of control are not required.

MEASLES

(*a*) *Infective Agent.*—Is unknown, but is known to be a filterable virus.

(*b*) *Source of Infection.*—Cases in the active and prodromal stages.

(*c*) *Exit of Infective Agent.*—In the buccal and nasal secretions.

(*d*) *Route of Transmission.*—By direct or indirect contact.

(*e*) *Incubation Period.*—Seven to eighteen days; practically always fourteen days.

(*f*) *Period of Communicability.*—During the period of catarrhal symptoms and until the cessation of abnormal mucous membrane secretions; which is from 2 days before, to 5 days after the appearance of the rash; a minimum period of seven days.

(*g*) *Entrance of Infective Agent into the Body.*—Probably by the mouth and nose.

(*h*) **Methods of Control.**—*The Infected Individual.*—1. Diagnosis: By the clinical manifestations. In exposed individuals pay especial attention to the rise in temperature, Koplik spots on the buccal mucosa and catarrhal symptoms.

2. Isolation: During the period of communicability.

3. Artificial immunization: None.

4. Quarantine: Exclude exposed susceptible school children and teachers from school for a period of one week dating from the last known exposure. This also applies to all public gatherings.

5. Concurrent disinfection: Of all articles soiled with the secretions of the nose and throat.

6. Terminal disinfection: Thorough cleaning.

General Measures.—1. Daily examination of exposed children during the incubation period, and of other persons presumably exposed. This examination should include a record of the body temperature. A non-immune exposed individual exhibiting a rise of temperature of 0.5 degree or more should be promptly isolated pending diagnosis.

2. Schools should not be closed or classes discontinued where daily observation of the children by a physician or nurse is possible.

3. Education of parents and others of the great danger from exposing young children to those exhibiting acute catarrhal symptoms of any kind.

MUMPS

(*a*) *Infective Agent.*—Unknown.

(*b*) *Source of Infection.*—Typical cases and atypical recurring cases.

(*c*) *Exit of Infective Agent.*—In the buccal and nasal secretions,

(*d*) *Route of Transmission.*—Direct and indirect contact.

(*e*) *Incubation Period.*—From 4 to 25 days, usually 18 days.

(*f*) *Period of Communicability.*—Unknown, but it is assumed to continue until the parotid gland has returned to normal size.

(*g*) *Entrance of Infective Agent into the Body.*—Probably by the mouth.

(*h*) **Methods of Control.**—*The Infected Individual.*—1. Diagnosis: Inflammation of Steno's duct may be of assistance in recognizing the early stage of the disease. The diagnosis is usually made from the swelling of the parotid gland.

2. Isolation: Separation of the patient from non-immune

children and exclusion of the patient from school and public places for the period of the presumed infectivity.

3. Artificial Immunization: None.

4. Quarantine: Limited to exclusion of non immune children from school and public gatherings for 21 days after their last exposure to a recognized case.

5. Concurrent disinfection: Of all articles soiled with the discharges from the nose and mouth.

6. Terminal disinfection: None.

General Measures.—Not required.

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CHAPTER VII

DISEASES USUALLY TRANSMITTED BY CONTACT (Continued)

GERMAN MEASLES

The public health importance of this disease is similar to that of chicken-pox, confusion with scarlet fever being not infrequent.

(*a*) *Infective Agent.*—Unknown.

(*b*) *Source of Infection.*—Typical cases and atypical missed cases of the disease.

(*c*) *Exit of Infective Agent.*—In the buccal and nasal secretions.

(*d*) *Route of Transmission.*—By direct and indirect contact.

(*e*) *Incubation Period.*—From 10 to 21 days.

(*f*) *Period of Communicability.*—For eight days from the onset of the disease.

(*g*) *Entrance of Infective Agent into Body.*—Probably by the the mouth.

(*h*) **Methods of Control.**—*Infected Individual.*—1. Diagnosis: Only by clinical manifestations.

2. Isolation: Separation of the patient from susceptible children, and exclusion from school and public places for the period of the presumed infectivity.

3. Artificial immunization: None.

4. Quarantine: None, except exclusion of non-immune children from school and public gatherings from 11 to 22 days from the date of exposure to a recognized case.

5. Concurrent disinfection: Of the discharges from the nose and throat and of all articles soiled with them.

6. Terminal disinfection: Airing and cleaning.

General Measures are not required.

SCARLET FEVER

(*a*) *Infective Agent.*—Is unknown; but by some is considered to be a streptococcus.

(*b*) *Source of Infection.*—Typical cases, atypical cases and carriers.

(*c*) *Exit of Infective Agent.*—In the secretions of the mouth and nose and in purulent discharges from suppurating ears and lymph nodes.

(*d*) *Route of Transmission.*—By direct or indirect contact; or by milk contaminated with buccal-pharyngeal secretions.

(*e*) *Incubation Period.*—From 2 to 7 days, usually 3 to 4 days.

(*f*) *Period of Communicability.*—Up until four weeks from the onset of the illness without regard to desquamation, and until all abnormal discharges have stopped and the open lesions have healed.

(*g*) *Entrance of Infective Agent into the Body.*—Probably by mouth or nose.

(*h*) **Methods of Control.**—*Infected Individual.*—1. Diagnosis: By clinical manifestations.

2. Isolation: At home or in a hospital, maintained until the termination of infectivity.

3. Artificial Immunization: None.

4. Quarantine: Exclusion of exposed susceptible children and teachers from school, and of food handlers from their work, until seven days have elapsed since the last known exposure.

5. Concurrent disinfection: Of all discharges of the patient and of all objects contaminated with them.

6. Terminal disinfection: Thorough cleaning.

General Measures.—1. Daily examination of exposed children and other susceptible contacts for a week after their last exposure.

2. Schools should not be closed where daily observation of the children by a physician or nurse is provided.

3. Education of parents and others in the danger of exposing children to those persons who exhibit acute catarrhal symptoms of any kind.

4. Pasteurization of all public milk supplies should be required.

SEPTIC SORE THROAT

(*a*) *Infective Agent.*—*Streptococcus hemolyticus.*

(*b*) *Source of Infection.*—Typical or atypical human cases or carriers. Cows may be healthy carriers, becoming infected from man.

(*c*) *Exit of Infective Agent.*—In the nasopharyngeal secretions of human beings, or in the milk of a carrier cow.

(*d*) *Route of Transmission.*—Direct or indirect human contact; consumption of infected cow's milk, or by contaminated cow's milk.

(*e*) *Incubation Period.*—From one to three days.

(*f*) *Period of Communicability.*—Indefinite and uncertain and can only be ascertained by a bacteriological examination.

(*g*) *Entrance of Infective Agent into the Body.*—Through the mouth or nose.

(*h*) **Methods of Control.**—*Infected Individual.*—1. Diagnosis: By clinical manifestations which should be confirmed by cultures from the throat and tonsils.

2. Isolation: During the clinical course of the disease and convalescence, especially by exclusion of the patient from the production or handling of milk or milk products.

3. Artificial Immunization: None.

4. Quarantine: None.

5. Concurrent Disinfection: Of discharges from the nose and throat and articles soiled therewith.

6. Terminal Disinfection: None.

General Measures.—1. Exclusion of a suspected milk supply from public sale or use until it has been pasteurized. The exclusion of the milk of an infected cow is possible in small herds if the infected animal is located by the bacteriological examination of all in the herd.

2. Pasteurization of all milk retailed to the public.

3. Education of the public in the principles of personal hygiene, especially in the avoidance of the use of common towels, and common drinking and eating utensils.

WHOOPING-COUGH

(*a*) *Infective Agent.*—*Bacterium pertussis.*

(*b*) *Source of Infection.*—Typical cases, atypical cases and carriers, and also dogs and cats.

(*c*) *Exit of Infective Agent.*—In the discharges from the laryngeal and bronchial mucous membranes.

(*d*) *Route of Transmission.*—By direct or indirect contact.

(*e*) *Incubation Period.*—Not over 14 days.

(*f*) *Period of Communicability.*—It is particularly communicable in the early catarrhal stages before the onset of the whooping. It probably does not persist longer than two weeks after the onset of the characteristic cough.

(*g*) *Entrance of Infective Agent into the Body.*—Through the mouth and nose.

(*h*) **Methods of Control.**—*The Infected Individual.*—1. Diagnosis: From the clinical manifestations, supported by a leucocyte count and by bacteriological examination.

2. Isolation: Separation of the patient from susceptible children and his exclusion from school and public places for the period of presumed infectivity.

3. Artificial Immunization: Some observers recommend the employment of *B. pertussis* vaccine, although the results do not seem to be uniformly effective.

4. Quarantine: Exclusion of non-immune children from school and public places for 14 days after their last exposure to a known case.

5. Concurrent Disinfection: Of the secretions of the mouth, nose and throat of patients, and of articles soiled therewith.

6. Terminal Disinfection: Cleaning.

General Measures.—Education of the public in habits of cleanliness and in the danger of association or contact with those showing catarrhal symptoms or with a cough.

INFLUENZA

(*a*) *Infective Agent.*—Unknown and disputed. Evidence for and against the *Bacterium influenzæ* is conflicting.

(*b*) *Source of Infection.*—Typical or atypical human cases.

(*c*) *Exit of Infective Agent.*—In the nasopharyngeal secretions.

(*d*) *Routes of Transmission.*—Direct or indirect human contact.

(*e*) *Incubation Period.*—One to three days.

(*f*) *Period of Communicability.*—Indefinite and uncertain.

(*g*) *Entrance of Infective Agent into the Body.*—Through the mouth or nose.

(*h*) **Methods of Control.**—*The Infected Individual.*—1. Diagnosis: From clinical manifestations.

2. Isolation: Separation of patients from susceptibles for the period of their illness.

3. Artificial Immunization: In the abscence of definite knowledge of the causative organism, there is no scientific basis for the employment of vaccines as a prophylactic measure, a fact which is substantiated by the universal failure of the various bacterins employed for this purpose in 1919. No methods of artificial active or passive immunization are at present known.

4. Quarantine: None.

5. Concurrent Disinfection: Of the secretions of the mouth and nose, and of articles contaminated therewith.

6. Terminal Disinfection: Cleaning.

General Measures.—Education of the public in habits of personal cleanliness and in the danger of association or contact with those showing catarrhal symptoms or with cough. The masking of all persons during epidemics is of value.

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CHAPTER VIII

DISEASES USUALLY TRANSMITTED BY CONTACT (Continued)

DIPHTHERIA

(*a*) *Infective Agent.—Mycobacterium diphtheriæ.*

(*b*) *Source of Infection.*—Typical or atypical cases or carriers.

(*c*) *Exit of Infective Agent.*—Most commonly in the secretions of the mouth and nose, which are contaminated from lesions situated in the nose and throat. Less frequent and of lesser importance are lesions on the conjunctiva, infection of wounds and of the vagina.

(*d*) *Routes of Transmission.*—By direct or indirect contact, and by milk or milk products contaminated with bucco-nasal secretions from cases or carriers.

(*e*) *Incubation Period.*—Usually 2 to 5 days, sometimes longer in the case of incubatory carriers.

(*f*) *Period of Communicability.*—Until virulent bacilli have disappeared from the secretions and lesions as determined bacteriologically. Their persistance is variable, in 75 per cent. of the cases they disappear within two weeks, in 95 per cent. within 4 weeks. In exceptional carriers they may persist for 2 to 6 months.

(*g*) *Entrance of Infective Agent into the Body.*—The organism does not penetrate the physiological interior of the body. Most commonly it gains access to the mouth or nose.

(*h*) **Methods of Control.**—*The Infected Individual.*—1. Diagnosis: Clinical manifestations together with bacteriological examination, or the latter alone.

2. Isolation: Until two consecutive negative cultures are secured from both the nose and the throat, taken not less than twenty-four apart and not less than 4 hours subsequent to the local employment of antiseptics. Some authorities advocate the termination of isolation with diphtheria bacilli present providing the latter give negative virulence tests.

3. Artificial Immunization: Susceptible contacts who are found to be carriers should be given prophylactic doses of

antitoxin. Contacts in whom the diphtheria bacillus is not found and who give a positive Schick reaction, indicating their susceptibility to diphtheria toxin, should be actively immunized by toxin-antitoxin mixtures, the administration of which is controlled by the Schick test.

The *Schick test* consists in the intracutaneous injection of $\frac{1}{50}$th of the M. L. D. of a diphtheria toxin contained in .1 to .2 c. c. of saline. A negative reaction is a sign of immunity, and a positive reaction a sign of susceptibility. Less than $\frac{1}{30}$th of an antitoxin unit per c.c. of blood makes an individual susceptible. A positive reaction runs the following course:

In from 12 to 24 hours there is a trace of redness
24 to 48 hours there is a distinct reaction
3 to 4 days the reaction is at a maximum and waning.
3 to 6 weeks there is a circumscribed area of scaling and for pigmentation. Pseudo reactions have a more rapid course and leave no pigmentation.

Active immunization against diphtheria toxin is accomplished by injecting overneutralized mixtures of toxin and antitoxin. These mixtures should contain per c.c. from eighty to ninety per cent. of the limes plus dose of toxin and one antitoxin unit. One c.c. is a dose and it should be given subcutaneously and repeated at intervals of six to eight days. This method of immunization is employed upon susceptibles to the toxin as revealed by the Schick test.

The employment of diphtheria antitoxin as a therapeutic agent effected a gross reduction in the mortality from diphtheria of 85 per cent. The present mortality from diphtheria is largely due to either its delayed administration or its employment in insufficient amounts. The following doses are recommended by Park and Biggs as minimal:

Minimal Dosages of Diphtheria Antitoxin

Patient	Mild	Moderate	Units in cases	
			Severe	Very severe
Under 1 yr.	2,000	3,000	10,000	10,000
1–5 yrs.	3,000	5,000	10,000	10,000
5–9 yrs.	4,000	5,000	10,000	15,000
10 yrs. and over	5,000	10,000	10,000	20,000

In any event its administration should be continued until the desired result is secured. It is better to give the above indicated amounts as one single dose and add additional quantities as the course of the case may require. The quickest results and the maximum benefit is secured from the intravenous route of injection. In order to guard against anaphylactic reactions, the possibility of the patient's sensitization to horse serum must always be borne in mind, and de-sensitization performed if necessary.

4. Quarantine: Of all exposed persons until shown to be free from infection by bacteriological examination.

5. Concurrent Disinfection: Of all secretions of the infected person and articles which have been contaminated therewith.

6. Terminal Disinfection: Thorough airing and scrubbing of the isolation quarters.

General Measures.—1. Pasteurization of the public milk supply.

2. Application of the Schick test to all children.

3. Application of the Schick test to all contacts and the active immunization of all found to be susceptible.

4. Active immunization by toxin-antitoxin mixtures of all susceptibles.

5. Determination of the presence or absence of carriers among the population at large.

MENINGOCOCCIC MENINGITIS (CEREBRO-SPINAL)

(*a*) *Infective Agent.—Micrococcus meningitidis.*

(*b*) *Source of Infection.*—Typical or atypical cases and carriers.

(*c*) *Exit of Infective Agent.*—In the secretions of the mouth and nose.

(*d*) *Routes of Transmission.*—By direct and indirect contact.

(*e*) *Incubation Period.*—Commonly 7 days, varying from 2 to 10. In the case of incubatory carriers it may be of longer duration.

(*f*) *Period of Communicability.*—Until the meningococcus is no longer present in the secretions of the nose and throat as determined bacteriologically.

(*g*) *Entrance of Infective Agent into the Body.*—Probably by the mouth and nose. Meningitis is probably a rather infrequent complication in an infection commonly localized to the naso-pharynx.

(*h*) **Methods of Control.** *Infected Individuals.*—1. Diagnosis: Clinical manifestations confirmed by bacteriological examination of the spinal fluid, or of the nasal and pharyngeal secretions.

2. Isolation: Until the naso-pharynx is free from the infecting organisms; or in the absence of bacteriological assistance, until one week after the fever has subsided.

3. Artificial Immunization: The employment of vaccines may prove of value, though still in the experimental stage.

The therapeutic employment of anti-meningococcus serum has effected a reduction of the mortality from this disease of from thirty to eight per cent as compared with the mortality in those not treated with the serum. The serum is given intraspinously after removal of an equal volume of spinal fluid. The recognition of at least four distinct types of meningococci, and the additional fact that antiserum produced against any one type alone is of but slight value in treating cases due to the other types, indicates the importance of employing either a polyvalent serum, or where facilities for determining the type of the infecting meningococcus are available the employment of the specific antisera against the infecting type strain. No quantity of serum can be regarded as a minimal dose. Its administration should be pushed until the desired effects are secured.

4. Quarantine: None.

5. Concurrent Disinfection: Of all the discharges from the mouth and nose and of articles soiled therewith.

6. Terminal Disinfection: None.

General Measures.—1. Search for carriers by the bacteriological examination of the secretions from the posterior nares of all contacts.

2. Education of the public in personal cleanliness and the avoidance of contact and droplet infection.

3. Prevention of overcrowding in living quarters, transportation conveyances, working places, and places of assemblage among civil populations, and in inadequately ventilated closed quarters and barracks, camps, and ships, among laboring, naval and military units.

POLIOMYELITIS

(*a*) *Infective Agent.*—Unknown. By Flexner believed to be a filterable virus, by Rosenow a streptococcus.

(*b*) *Source of Infection.*—Typical and atypical cases and carriers.

(*c*) *Exit of Infective Agent.*—In the secretions of the mouth and nose and in the intestinal discharges.

(*d*) *Routes of Transmission.*—By direct or indirect contact, and also possibly by flies.

(*e*) *Incubation Period.*—Three to ten days, commonly six.

(*f*) *Period of Communicability.*—Unknown. Apparently not for more than 21 days from the date of onset of the disease, but it may precede the onset of the symptoms by several days.

(*g*) *Entrance of Infective Agent into the Body.*—Probably through the mouth or nose.

(*h*) **Methods of Control.** *Infected Persons.*—1. Diagnosis: From clinical manifestations assisted by chemical and microscopical examination of the spinal fluid.

2. Isolation: Of all recognized cases in screened rooms.

3. Artificial Immunization: None.

4. Quarantine: Of exposed contacts among children, and of adults whose occupation brings them in contact with children, or who are food handlers, for 14 days from the date of their last exposure.

5. Concurrent disinfection of the nose, throat and bowel discharges, or articles soiled therewith.

6. Terminal Disinfection: Cleaning.

General Measures During Epidemics.—1. A search for and an examination of all sick children, should be made.

2. All children with fever should be isolated pending diagnosis.

3. Education of the general public in personal cleanliness and the avoidance of contact opportunities.

LOBAR PNEUMONIA, ACUTE

(*a*) *Infective Agent.*—*Streptococcus pneumoniæ.*

(*b*) *Source of Infection.*—Typical cases and carriers.

(*c*) *Exit of Infective Agent.*—In the sputum and saliva.

(*d*) *Routes of Transmission.*—Direct and indirect contact.

(*e*) *Incubation Period.*—Short, usually two to three days.

(*f*) *Period of Communicability.*—Of unknown duration, presumably until the pneumococcus is no longer present.

(*g*) *Entrance of Infective Agent into the Body.*—Through the mouth or nose.

(*h*) **Methods of Control.** *The Infected Individuals.*—1. Diagnosis: By the clinical manifestations. The specific strain of the

pneumococcus involved may be determined by bacteriological and serological tests early in the disease.

2. Isolation: During the clinical course of the disease.

3. Artificial immunization: Polyvalent vaccines offer considerable promise although still experimental.

Fairly successful antibacterial serum has been produced against one of the several known types of the pneumococcus, but passive immunizatioan has as yet proven of little value against infection with the other types. Hence the desirability of early ascertaining the type of the infecting strain of the pneumococcus, since if it is found to be type I, the prognosis can be favored by the therapeutic employemnt of type I antiserum. The serum is given intravenously in large doses, starting with 75 to 100 c.c. and repeating every eight hours. The average requirements are about 250 c.c.

4. Quarantine: None.

5. Concurrent disinfection: Of all discharges from the mouth or nose and of articles soiled therewith.

6. Terminal disinfection: Cleaning.

General Measures.—1. Overcrowding should be carefully avoided in institutions and camps. The general resistance of healthy persons should be conserved by good feeding, fresh air, and temperance in the use of alcoholic beverages.

TUBERCULOSIS (PULMONARY)

(*a*) *Infective Agent.*—*Mycobacterium tuberculosis*, most commonly the human strain.

(*b*) *Source of Infection.*—Typical or atypical cases.

(*c*) *Exit of Infective Agent.*—The most important portal of exit is by means of the sputum. The bacilli may also leave the body in the discharges from the intestinal and genito-urinary tracts, or in discharges from lesions of the lymphatic glands, bone and skin.

(*d*) *Route of Transmission.*—By direct and indirect contact.

(*e*) *Incubation Period.*—Prolonged and variable, depending upon the type of disease.

(*f*) *Period of Communicability.*—Commences when a lesion becomes open and continues until it heals or death supervenes. It is of variable duration though usually prolonged.

(*g*) *Entrance oj Injective Agent into Body.*—By the mouth or the nose, passing either directly to the lungs by the inhalation of the organisms, or by way of the upper thoracic lymphatic

system; or by ingestion of bacilli from the intestinal tract, passing from thence to the lungs by the lymphatics. Apparently infection takes place in early life, prior to the age of ten. The disease then remains latent until several years later, until adolescence or early adult life.

(*h*) **Methods of Control.** *The Infected Individual.*—1. Diagnosis: By clinical manifestations and bacteriological examination of the sputum.

2. Isolation: Only of such open cases that do not observe the precautions necessary to prevent the spread of the disease.

3. Artificial Immunization: None.

4. Quarantine: None.

5. Concurrent Disinfection: Of the sputum and of articles contaminated therewith.

6. Terminal Disinfection: Cleaning and renovation of the occupied quarters.

General Measures.—1. Education of the public regarding the dangers of tuberculosis and the necessary measures for its prevention and control, with special stress laid upon the dangers of exposure and infection in early childhood.

2. Provision of dispensaries and visiting nurse service for the discovery of early cases, and the supervision of home cases.

3. Provision of hospitals for the isolation of advanced cases and of sanitaria for the treatment of early cases.

4. Provision of open-air schools for pretubercular children.

5. Improvement in housing conditions, particularly dealing with overcrowding, inadequate lighting and ventilation, as well as improving the nutrition of the poor.

6. The ventilation and elimination of dust in industrial establishments and places of public assembly.

7. Improvement in the personal hygiene of the public, particularly preventing promiscuous expectoration, and a betterment of the general living conditions.

8. Separation of babies from tuberculous mothers at their birth.

LEPROSY

(*a*) *Infective Agent.*—*Mycobacterium lepræ.*

(*b*) *Source of Infection.*—Probably typical and atypical human cases.

(*c*) *Exit of Infective Agent.*—In the discharges from nasal lesions and ulcerated areas elsewhere on the body.

(*d*) *Routes of Transmission.*—By close, intimate and prolonged contact with infected persons, and possibly by insects.

(*e*) *Incubation Period.*—Prolonged and unknown.

(*f*) *Period of Communicability.*—Throughout the duration of the disease, but apparently where good standards of hygiene prevail this disease is but slightly communicable. The disease may in some cases be controlled by the chalmoogra oil treatment.

(*g*) **Methods of Control.** *The Infected Individual.*—1. Diagnosis: By clinical manifestations and bacteriological examination.

2. Isolation: Of a nominal character, approximating that suitable to tuberculosis.

3. Artificial Immunization: None.

4. Quarantine: None.

5. Concurrent Disinfection: Of all discharges and articles soiled therewith.

6. Terminal Disinfection: Thorough cleaning.

General Measures.—1. Provision of public hospitals for the exclusive care of lepers. Under suitable conditions of environment, together with a proper attitude on the part of the patient, he may be allowed to remain at his home premises under supervision.

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CHAPTER IX

DISEASES FREQUENTLY TRANSMITTED BY CONTACT

As previously stated this group includes the diseases whose infective agents leave the body chiefly in the excrement, *i.e.*, the feces and urine. Thus we have to consider the following:

Typhoid and Paratyphoid fevers: *i.e.*, the Enteric fevers.

Asiatic Cholera.

The Dysenteries, particularly the bacillary and amœbic forms.

Hookworm Disease.

THE ENTERIC GROUP

(*a*) *Infective Agents.*—*Bacterium typhosus*, *Bacterium paratyphosus A*, *Bacterium paratyphosus B*.

(*b*) *Source of Infection.*—Typical and atypical cases and carriers.

(*c*) *Exit of Infective Agents.*—Principally in the feces and urine. Of lesser importance are the sweat, sputum, human milk and pus.

(*d*) *Routes of Transmission.*—By direct or indirect contact, also by water, milk or dairy products, shell-fish and other raw or uncooked foods contaminated with excrement, and through mechanical transmission by house flies (See Fig. 3). These other routes will be considered in detail later.

(*e*) *Incubation Period.*—From 7 to 23 days, averaging 10 to 14 days.

(*f*) *Period of Communicability.*—From the appearance of the prodromal symptoms, throughout the illness and relapses, during convalescence, and until the excrement is bacteriologically found to be free of the bacillus. Carriers may harbour the organisms for a long period of years.

(*g*) *Entrance of the Infective Agents into the Body.*—By the mouth to the intestinal tract.

(*h*) **Methods of Control.** *The Infected Individual.*—1. Diagnosis: Clinical manifestations, confirmed by bacteriological examinations of the blood, feces, and urine; and by the Widal test.

2. Isolation: In a fly proof room, preferably under hospital conditions for such cases that cannot command adequate sanitary environment and nursing care in their homes.

3. Artificial Immunization: Bacterial vaccines have given highly satisfactory results as a prophylactic. They should be employed on susceptibles who are known to have been exposed or who are suspected of being exposed.

Furthermore, their widespread employment among the population at large should be encouraged. Best evidence of their value is afforded by the experience of the American and other armies. Thus in the Maneuver Division of the U. S. Army at San Antonio, Texas in the summer of 1911, with a mean strength of 12,801 men, all vaccinated, there were from March 10th to July 10th, only two cases of typhoid. One of these cases had not been vaccinated, the other had not completed the course. As a consequence of vaccination, there was in the period between 1909 and 1914, only one death from typhoid in the army (about 80,000 men), while the death rate in the country at large averaged over 16.5 per hundred thousand.

The immunity varies in degree and also in duration, though when produced by a series of inoculations on the army plan, it probably may be depended upon for two or three years.

Combined vaccines, prepared from the typhoid bacillus and the alpha and beta paratyphoid bacilli are preferable, of which the typhoid bacillus comprises 50 per cent. of the organisms in suspension. The common suspensions have approximately two billion dead bacteria per c.c. The initial dose is one billion and later doses two billion bacteria. At least three and preferably four inoculations should be given. The inoculations are made subcutaneously at the point of insertion of the deltoid, after the site has been painted with tinture of iodine. The inoculations should be spaced about one week apart. Most people only experience a local reaction. The general reaction, which appears within twenty fours and rapidity subsides, is never serious and consists of malaise, muscular soreness and fever.

4. Quarantine: None.

5. Concurrent Disinfection: Of all bowel and urinary discharges and of all objects contaminated by them.

6. Terminal Disinfection: Cleaning.

General Measures.—1. Purification and disinfection of public water supplies.

2. Pasteurization of public milk supplies.

3. Supervision of food supplies and of persons employed as food handlers.

4. Prevention of fly breeding.

5. Sanitary disposal of human excreta.

6. Extension of the public immunization by vaccination as far as practicable.

7. Recognition of typhoid carriers and their exclusion from the handling of foods to be consumed by others.

8. Systematic searches for carriers.

9. Exclusion of suspected milk supplies pending the discovery of the person or other cause of the infected condition of the milk.

10. Exclusion of a water supply if contaminated, until adequately treated with hypochlorite or other disinfectant, unless the water used for toilet, cooking and drinking purposes is boiled before use.

ASIATIC CHOLERA

(a) *Infective Agent.—Spirillum choleræ*

(b) *Source of Infection.*—Typical and atypical cases and carriers.

(c) *Exit of Infective Agent.*—In the bowel discharges and vomitus.

(d) *Routes of Transmission.*—By direct or indirect contact, by food or water contaminated with excrement or by flies.

(e) *Incubation Period.*—One to five days, usually three, occasionally longer if the stage of incubatory carrier precedes the onset.

(f) *Period of Communicability.*—Usually 7 to 14 days or longer, and until the vibrios have disappeared from the bowel discharges as determined bacteriologically. Chronic carriers are not uncommon.

(g) *Entrance of Infective Agent into the Body.*—By the mouth to the intestinal tract.

(h) **Methods of Control.** *The Infected Individual.*—1. Diagnosis: Clinical manifestations, confirmed bacteriologically.

2. Isolation: In a hospital or screened room.

3. Artificial Immunization: Vaccination is still in the experimental stages.

4. Quarantine: Contacts should be detained for five days from the date of their last exposure, or longer if one is found to be a carrier.

5. Concurrent Disinfection: Of the stools and vomitus. All

objects probably and certainly contaminated should be disinfected. Food left by the patient should also be disinfected.

6. Terminal Disinfection: Bodies of those dying from cholera should be cremated if possible, otherwise wrapped in a sheet saturated with a disinfectant and buried in water tight caskets. The isolation quarters should be thoroughly cleansed and disinfected.

(*a*) Attendants must protect themselves and others by rigid attention to scruplous cleanliness, disinfection of the hands each time after handling the patient or touching articles contaminated by dejecta, the avoidance of eating or drinking anything in the room of the patient, and should be prohibited from entering the kitchen.

(*b*) The bacteriological examination of all contacts to detect carriers, and the isolation of those found.

(*c*) Water should be boiled if used for drinking or toilet purposes, or if used in washing dishes or food containers, unless the supply is protected against contamination, or is treated by chlorination.

(*d*) Careful supervision of food and drink. When cholera is present only cooked foods should be eaten, while after cooking its contamination either by flies or handling should be prevented.

Epidemic Measures.—The following measures should be employed in emergencies.

Inspection service for the early detection and isolation of cases; the examination of all persons exposed to cholera in infected centers for the detection of carriers, with the isolation or control of those discovered; disinfection of the rooms occupied by the sick; and the temporary quarantine detention in suitable camps of those desiring to leave for another locality. These before leaving should be examined bacteriologically to detect possible carriers.

AMŒBIC DYSENTERY

(*a*) *Infective Agent.*—*Entamæba histolytica.*

(*b*) *Source of Infection.*—Typical and atypical cases and carriers.

(*c*) *Exit of Infective Agent.*—In the feces and bowel discharges.

(*d*) *Route of Transmission.*—By direct and indirect contact, and by food or drink contaminated with bowel discharges, or by flies.

(*e*) *Incubation Period.*—Unknown.

(*f*) *Period of Communicability.*—During the active stage of the disease and as long as cysts are discharged.

(*g*) *Entrance of Infective Agent.*—By the mouth to the intestinal tract.

(*h*) **Methods of Control.** *The Infected Individual.*—1. Diagnosis: Clinical manifestations, confirmed by the detection of trophozoites and cysts in the stools.

2. Isolation: None.

3. Artificial Immunization: None.

4. Quarantine: None.

5. Concurrent Disinfection: Of the bowel discharges and articles soiled therewith.

6. Terminal Disinfection: Cleaning.

General Measures.—1. Boil the drinking water unless the supply is known to be free from fecal contamination.

2. Water supplies should be protected from fecal contamination, and official supervision should be exercised over all foods eaten raw.

BACILLARY DYSENTERY

(*a*) *Infective Agent.*—*Bacterium dysenteriæ*, all types.

(*b*) *Source of Infection.*—Typical and atypical cases and carriers.

(*c*) *Exit of Infective Agent*—.In the feces and bowel discharges.

(*d*) *Route of Transmission.*—By direct or indirect contact, by contaminated food or water, and by flies.

(*e*) *Incubation Period.*—From two to seven days.

(*f*) *Period of Communicability.*—During the "dysenteric" period of the disease and until the bacilli are absent from the bowel discharges, as determined bacteriologically. Chronic carriers may develope.

(*g*) *Entrance of Infective Agent.*—By the mouth to the intestinal tract.

(*h*) **Methods of Control.** *The Infected Individual.*—1. Diagnosis: By clinical manifestations, confirmed by serological tests and bacteriologic examination of the stools.

2. Isolation: Of infected persons until they no longer discharge the bacilli.

3. Artificial Immunization: Vaccines give considerable immunity. Owing to severe reactions their use is not universal, nor should it be made compulsory except in an extreme emergency.

4. Quarantine: None.

5. Concurrent Disinfection: Of bowel discharges and all objects soiled therewith.

6. Terminal Disinfection: Thorough cleaning.

General Measures.—1. Rigid attention to personal prophylaxis by the attendants upon infected persons.

2. No milk or food should be sold from premises where exists a case of dysentery, nor should the patient's attendants be food handlers for others.

3. Protection of drinking water by boiling or chlorination, and the safeguarding of the supply from fecal contamination.

4. Protection of food from flies.

We next have to consider hookworm disease or uncinariasis. It is questionable whether hookworm disease is ever spread by contact, hence its inclusion in this group is not proper. However it does have one characteristic common to all other diseases of this group, inasmuch as its infective agent leaves the body in the feces. Hence its consideration here. Hookworm infection is the only helminthic infection widespread in the United States and producing sufficient systemic disturbances to demand detailed consideration.

UNCINARIASIS (HOOKWORM DISEASE)

(*a*) *Infective Agent.*—*Necator americanus* and *Anchylostoma duodenale.*

(*b*) *Source of Infection.*—Typical and atypical cases and carriers.

(*c*) *Exit of Infective Agent.*—The ova are discharged in the feces.

(*d*) *Routes of Infection.*—By fecal contaminated soil, by contaminated drinking water, and possibly by direct contact.

(*e*) *Incubation Period.*—From seven to ten weeks.

(*f*) *Period of Communicability.*—As long as the ova are passed, hence as long as the patient harbors the adult worms.

(*g*) *Entrance of the Infective Agent into the Body.*—Larval worms present in the soil and which have hatched from ova discharged in the feces, penetrate the skin of the foot between the toes, gain access to the circulation, are caught in the pulmonary capillaries, pass into the pulmonary alveoli, go up the bronchi to the larynx and down the oesophagus to the intestine, or are ingested with contaminated drinking water. Contaminated soil remains infected for about five months in the absence of freezing.

(*h*) **Methods of Control.** *Infected Person.*—1. Diagnosis: By clinical manifestations, confirmed by the microscopic examination of the feces.

2. Isolation: None.

3. Artificial Immunization: None.

4. Quarantine: None.

5. Concurrent disinfection of the feces

6. Terminal Disinfection: None.

General Measures.—1. Installation of sanitary privies upon living premises and the education of people in their proper use.

2. The safeguarding of domestic water supplies from fecal contamination.

3. The wearing of shoes outside the home.

4. The treatment of infected persons by thymol and oil of chenopodium.

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CHAPTER X

GENERAL MEASURES OF DISEASE CONTROL

There are fundamental measures underlying the whole problem of disease control to some of which we have previously referred. Among them the following groups may be distinguished, the first two of which will be considered at present. They are the following:

(*a*) The control of recognized sources of infection.

(*b*) The control of susceptible contacts.

(*c*) The destruction of insect vectors.

(*d*) The control of routes of infection other than contact. The last two of these will be considered in later chapters.

PROCEDURE WITH RECOGNIZED OR SUSPECTED SOURCES OF INFECTION

In the event that we are dealing with a disease of the lower animals, the work is much simplified by the prompt destruction and incineration of those infected, except in the case of those which have a high monetary value, as for example pedigreed or highly bred livestock, in which event their lives may be spared and the same measures applied to them, with suitable modifications, as the following which are applied to human beings.

(*a*) *Isolation.*—By isolation we mean the separation of persons suffering from a communicable disease, or carriers of the infecting organism, from other persons, in places and under conditions that prevent the direct or indirect conveyance of the infective agent to other persons. The degree necessary to accomplish this result will vary with different diseases, as indicated in the previous chapters.

(*b*) *Quarantine.*—By quarantine we mean the limitation of the freedom of movement of persons or animals who have been exposed to a communicable disease for a period of time equal to or slightly greater than the incubation period of the disease to which they have been exposed. It implies that the persons or animals to be supervised are susceptible to the infection. The limitations necessary are of varying degree, ranging from a mere surveillance to an actual isolation.

CONDITIONS OF ISOLATION

(*a*) Isolation should be continued for the period of the individual's infectivity. Its termination should be determined by bacteriological means where possible or practicable, otherwise the clinical condition of the individual is the only criterion, in which event it should be continued until complete convalescence.

In many instances, either by reason of the economic condition of the patient or his family, or because the case occurs in the person of a transient, it is impossible to isolate the patient at his dwelling. In this event it is necessary to effect a removal of the patient to some place where satisfactory isolation may be successfully accomplished. If the patient is to remain at home, he must be removed to a room or suite of rooms not frequented by other members of the family, and attended by an individual who gives his sole attention to the patient's care. Preferably, and in some cases necessarily, the attendant must be a trained nurse, because it is impossible for a layman to suddenly acquire a subconscious familarity with the routine of isolation procedures. Under no circumstances must the attendant be one who prepares food or food stuffs to be consumed by other persons than the patient. The attendants should if possible be individuals who are either naturally or artificially immunized to the disease in question.

From the standpoint of the patient's cheer, as well as promoting natural disinfection, the isolation rooms should be sunny, well ventilated, and screened. All surplus furnishings should be removed. Within the room should be placed a tub of disinfectant solution and a basin of a suitable disinfectant should be kept on a stand just outside the door.

All of the members of the family and visitors should be excluded. The only visitors permitted should be the attending physician or the representative of the health authorities. When entering the room to minister to the patient, the attendant should don a gown that protects the outer clothing, and before leaving the room thoroughly wash his hands in the disinfectant. Contaminated objects should be immersed in the tub of disinfectant before their removal. The general precautions to be observed by the attendant will be discussed later.

Where satisfactory conditions of isolation cannot be provided at the patient's home, that individual should be removed elsewhere. Large cities provide special isolation hospitals for this

purpose. Small communities rarely have such facilities and in the event of an epidemic frequently isolate patients in hospital tents.

Isolation hospitals, as at present constructed are of two types, namely the so-called pavilion plan and the cubicle plan.

The pavilion plan is of English origin. It involves the classification of the patients upon admission according to their illness and their direction to separate wards or pavilions where are segregated all patients suffering from the same disease. Each ward or pavilion has a separate staff of attendants. In a large city such a hospital may give satisfactory results if carefully

FIG. 5.—Gates bedside screen in use at Naval Hospital, Newport, R. I. The screens reduce droplet transference, as well as affording greater privacy. *(From Gates, U. S. Naval Med. Bull., January, 1918.)*

operated, but several disadvantages exist. First, a large initial investment to build the separate wards or pavilions is necessary, and the administration is not flexible. Second, patients admitted may already be incubating a second disease, or a mistake in a diagnosis may have been made, so that the patients in a given ward are exposed to a second infection, and the newly admitted patient is also exposed, so that re-infections or "cross" infections are not unusual. The disease is the unit considered.

The cubicle plan is of French origin, having been developed in the hospital of the Pasteur Institute by Grancher. As applied the character of the institution where the patients are housed is of secondary importance, the feature of prime im-

portance being the nursing technique employed. This is termed medical asepsis as contrasted with the surgical asepsis of the operating room. Its effort is to prevent the transfer of infective agents from one patient to another. The patient is the unit considered. From the standpoint of hospital operation the aseptic technique aims to confine each different infection to a physically separate unit. The patients may be confined in separate rooms or be in wards. In the latter event the beds are placed at least six feet apart and separated by screens to prevent droplet transference. (Fig. 5). Where the nursing staff is thoroughly drilled in the following instructions, cross infections are exceedingly rare, mistaken diagnoses do not endanger the other patients and the elasticity of operation makes the expenses much lower. The success however, depends entirely on the proficiency of the nursing staff in the aseptic technique.

PRINCIPLES OF ASEPTIC TECHNIC

The nurses wear short sleeved uniforms with skirts at least five inches from the floor, also a cap. Large gowns are worn by nurses and doctors only when in intimate contact with patients. The sleeves of the gown extend to the wrists and are confined by rubber bands. Before entering a unit, a gown which is always kept hanging outside the unit when not in use is slipped over the uniform, and when leaving the gown is removed and the hands immediately scrubbed in a disinfectant solution.

The following rules must be constantly borne in mind by the nurses and attendants:

(*a*) Touch nothing pertaining to the patient except with your own hands and then scrub the hands thoroughly. Touch nothing unnecessarily.

(*b*) Keep fingers, pencils, pens, labels and everything of that sort out of your own mouth.

(*c*) Wash your hands frequently and always before leaving a unit or ward or before eating.

(*d*) After handling a patient do not touch your face until your hands are washed.

(*e*) Do not allow patients to cough or sneeze in your face.

(*f*) If rendering an intimate service it is best to wear a gauze mask over the mouth and nose.

(*g*) Do not kiss a patient or allow him to touch your face.

(*h*) Do not eat anything a patient may wish to give you.

(*i*) Keep and use only your own drinking glass.

(*j*) Remember that infections are spread chiefly by contact.

(*k*) Never lean against the bed or furniture in the unit.

(*l*) Always take into a unit everything required to serve the patient before becoming contaminated.

The foregoing principles are just as important in home as in hospital isolations.

Isolation in the case of biologically transmitted diseases is effective if the insect vectors are absolutely excluded or destroyed.

THE VALUE OF MASKS

In our opinion masking is a very valuable protective measure against any of the acute contact transmitted infections, of

FIG. 6.—Durand hospital mask, devised by Miss Charlotte Johnson, superintendent: The gauze (44 by 40 mesh) is cut 8 inches wide and 23 inches long. The sides and one end are turned down one-quarter inch. It is folded twice, the unturned end first, making a $7\frac{1}{2}$-inch square. The opposite diagonal corners are cut off 1 inch and the raw edge is turned in one-half inch. It is stitched firmly all around. A 1-inch dart $1\frac{1}{2}$ inches long is taken up at the middle of each side of the mask. A 14-inch tape is sewed on the opposite uncut corners. This mask has the advantage of covering the nose and mouth and in making the traction on the chin and not drawing on the nose and lips. (*From Weaver, Jour. Am. Med. Assoc.*, 71–17. p. 1405.)

greatest value as a protection for physicians, nurses, and others in close contact with infected persons, as well as a measure to be recommended to the public as a protection during epidemics

of highly contagious virulent infections. Masks possess a two fold value. Over the mouth and nose of an infected person they reduce, if not altogether eliminate, the distribution of an infected mouth spray. On the attendants of the sick or the uninfected populace they reduce the probabilities for inhalation of infected droplets, as well as serving as a continuous reminder that the fingers should be kept away from the mouth. In order that the maximum benefit be secured, certain definite specifications in their manufacture should be observed, and the masks should be changed and disinfected at intervals of three or four hours. According to Weaver, masks made of three layers of absorbent gauze, of a mesh of forty-four by forty are satisfactory for ordinary use, and while in caring for very virulent infections six layers should be employed. Masks will not prevent the introduction of infective agents into the nasal passages via the lachrymal ducts or conjunctivæ. It may be necessary to supplement them by suitable goggles when an individual is exposed to mouth spray. Their construction and adjustment is shown in Fig. 6.

CONCOMITANT DISINFECTION (CONCURRENT DISINFECTION)

Effective isolation demands the careful collection of all the infective discharges as soon as voided, and the immediate destruction of the infective agents present, or of objects that have been contaminated with them, before their removal from the isolation quarters or the unit. This is known as concomitant disinfection. It is essential that it be followed out in a careful and systematic manner. If the regimen of concurrent disinfection has been carefully followed there should be no need for gaseous disinfection at the termination of the isolation, a thorough cleaning should abundantly suffice. During the stage of the acute illness the attendant alone can carry this out. When convalescence is established it will be necessary to instruct the patient and secure his co-operation.

TERMINAL DISINFECTION

By this we mean the process of rendering the clothing and environment of the patient free from the possibility of conveying infection to others at a time when the patient is no longer a source of infection, or we may also apply this term to the disinfection of the premises occupied prior to the death of the patient,

or his removal elsewhere in the infective period of his illness. In the event that concurrent disinfection has been faithfully carried out, the patient's environment will undoubtedly not be contaminated and a prompt cleaning of the premises by scrubbing and washing will be adequate. On the other hand, if the patient is removed from the premises where he first took sick, or early death has occured before an effective regimen of concomitant disinfection had been established, there is every reason to believe that the quarters are contaminated, and then the cleansing may be supplemented by gaseous disinfection, either with sulfur dioxid or with formaldehyde.

THE TERMINATION OF ISOLATION

When the patient is deemed to be no longer harboring the infective agent, either as a result of clinical judgement or bacteriological examinations, he may be released from detention. Prior to this a thorough bath should be given and the patient dressed in fresh clothing. He may then be removed from the quarters of his detention and given as much freedom as his physical condition warrants. The isolation quarters are then treated as previously described.

SUCCESS OF ISOLATION

As a public health measure the success of the foregoing method in reducing the prevalence of a given disease will be inversely proportional to the number of unrecognized infective persons at large. If the latter are extensive the careful isolation of the known infective persons will accomplish little in the checking of an epidemic. On the other hand, from the standpoint of checking the development of secondary cases in the patients household, isolation, even under the latter circumstances should be carried out. Premature release of patients from isolation is indicated by the development of the so-called return cases. These are cases arising among the patient's associates following his return home. Their occurrence always call-for a re-examination of the released patient. The value of isolation according to different degrees of care observed is well shown by the following observations of G. B. Young in Chicago. Three different classes of isolation in the home were made:

A. Isolation with a trained attendant.

B. Isolation without a trained attendant.

C. Isolation in the home impossible. When possible cases in this class were hospitalzied.

The following results were secured with scarlet fever and diphtheria.

TABLE III

Diphtheria, March 15, 1914 to Nov. 1, 1914.

	No. cases	Susceptibles	Secondary cases	Per cent.
A. Isolation.....	139	496	0	0.0
B. Isolation.....	508	2,279	6	1.18
C. Isolation.....	2,024	9,136	98	4.88
Hospitalized	656	1,903	1	0 15

Scarlet Fever, March 15, 1914 to Nov. 1, 1914

	No. cases	Susceptibles	Secondary cases	Per cent.
A. Isolation.....	92	112	1	1.087
B. Isolation.....	306	234	16	5.22
C. Isolation.....	870	865	60	6.9
Hospitalized.....	430	315	10	2.32

SUSCEPTIBLES

Individuals who do not give a history of a previous attack of the disease in question should be regarded as susceptibles and also those whose active artificial immunization was received prior to its average period of duration. In the following diseases, however, one attack is followed by a permanent immunity, namely: plague; typhoid fever (second attacks in only about 2.4 per cent).; cholera; small pox (second attack rare); chicken pox (second attack rare); scarlet fever (second attacks in about 0.7 per cent); measles (second attack uncommon, but less rare than in scarlet fever); yellow fever, typhus fever; syphilis (reinfection rare but is possible if a cure of the preceding infection has been secured); mumps and poliomyelitis. In the following, on the other hand, the active immunity is more or less transitory, so the probabilities favor susceptibility, namely: gonorrhoea, influenza, glanders, dengue fever, diphtheria (second attack in 0.9 per cent. of cases, while 0.01 antitoxic unit per c.c. of circulating blood protects (negative Schick reaction) relapsing fever, tetanus and tuberculosis.

Susceptibles exposed on different dates should not be quarantined together, otherwise some, who were not infected by their first exposure, may become infected from their quarantined associates. Concommitant disinfection should be practiced. Daily search for prodromes should be made and upon their appearance isolation of the patient should be inaugarated. Susceptible contacts should be given active artificial immunization as early as possible and passive immunization where special circumstances suggests its advisability.

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CHAPTER XI

GENERAL MEASURES OF DISEASE CONTROL (Continued)

1. Modern methods for the control of communicable disease require that the health authorities have a prompt knowledge of how, when, and where cases of these diseases are occurring. With this information efficient officials can secure results, without it their efforts are of little value. This information is secured from various sources among which the following may be mentioned:

(*a*) Notification of cases by physicians.
(*b*) Laboratory reports.
(*c*) Reports by visiting nurses.
(*d*) School inspection.
(*e*) House to house searches.
(*f*) Reciprocal notification from other health authorities.
(*g*) Gossip and newspaper clippings.
(*h*) Carrier searches and searches among contacts.
(*i*) Householders and teachers reports.

The foregoing are listed very nearly in their importance as sources of information, the first of these being the most important.

2. **Physicians Duties in the Reporting of Disease.**—This duty is a legal one though the details of the obligation vary in different political units. In a general way one may say that the responsibility for the initiation and enforcement of control measures is one of the health authorities, while the responsibilities of the physician relate to the care of the patient. In communities where health work is poorly organized the line of demarcation is indefinite. The physician is an important source of morbidity information to the health authorities. His reports should give the following information: they should be in writing (for legal reasons), and state the name, age and sex of the patient, his address, place of residence, name of disease, occupation, place of employment or school attended, and the physician's signature. These are usually sent to the Health Officer. Reporting should be required as soon as a diagnosis is reached and doubtful cases should also be reported. A separate report should be made for each case.

3. **The Reportable Diseases.**—The diseases whose notification is required differ in various political units. They usually include a greater or less number of the diseases which are included in the standard morbidity law, (though the inclusion of some is of doubtful importance from the standpoint of public health), namely:

Actinomycosis	Small-pox
Acute infectious conjunctivitis	Syphilis
Anchylostomiasis (uncinariasis)	Tetanus
	Mumps
Anthrax	Paratyphoid fever
Cerebrospinal meningitis, epidemic	Scarlet fever
	Plague
Chicken pox	Pneumonia, acute lobar
Cholera	Poliomyelitis
Gonorrhea	Rabies
Leprosy	Rocky Mountain Spotted Fever
Malaria	
Measles	Trachoma
Dengue	Trichiniasis
Diphtheria	Tuberculosis, pulmonary
Dysentery, amoebic	Tuberculosis, other than pulmonary
Dysentery, bacillary	
Favus	Typhoid fever
German measles	Typhus fever
Glanders	Whooping-cough
Septic sore throat	Yellow fever.

4. Prompt reporting, which is necessary, depends upon the following:

(*a*) Realization by physicians of the necessity for reporting cases from a public health standpoint.

(*b*) Enforcement of statutes and ordinances, etc; requiring reporting.

(*c*) Provision of public and private facilities for the promotion of early diagnosis. The clinical diagnosis of typical cases is fairly easy, but atypical cases, exotic diseases, or those whose clinical recognition may be delayed, will have to be diagnosed by means of laboratory assistance. Hence public laboratory service should be available for this purpose.

5. Estimates of the diseases prevalence are of value to the health officer for the purpose of checking the completeness of the morbidity reports. For this purpose the following may be employed:

(*a*) Percentages or ratios secured from autopsy returns.

(*b*) The scrutiny of the mortality reports, to ascertain if the patients dying from the reportable diseases were previously reported during life as cases.

(*c*) Estimates based upon the mortality returns by the use of case-mortality ratios. Thus the mortality from typhoid fever is ordinarily considered to be 10 per cent. and if 10 deaths occured during a given period, one would expect that in the same interval there had occured approximately 100 cases.

(*d*) One of the most useful means of promptly checking the unusual occurrence of disease, that is of recognizing incipient epidemics in order that effective control measures may immediately be inaugurated, is the so-called endemic index. The endemic index is the average number of cases occuring in a given area during a given period of time, in each of five consecutive years exclusive of epidemics. The average secured is used for comparative purposes with the number of cases reported in later periods.

6. **Reciprocal Notification.**—Present day means of transportation are steadily progressing in speed. As a consequence a person infected on the other side of the world may travel half the globe before the expiration of the period of incubation. Consequently infective agents can be transported great distances by apparently healthy persons. Furthermore those who are actively infected, either cases or carriers, recognized or unrecognized, may travel about evading the health authorities and spread infective secretions in their path. Health officers can secure valuable assistance in detecting the possible spread of infective agents by travellers from distant points, by keeping informed of the prevalence of these diseases in jurisdictions other than their own. In the United States a knowledge of the prevalence of reportable diseases in other jurisdictions may be gained from the Public Health Reports published weekly by the Federal Public Health Service. This bulletin also publishes world wide summaries of the occurrence of plague, cholera, typhus, and small-pox, which latter summaries are also published in the Monthly Bulletin of the International Office of Public Health Hygiène, published in French from Paris. In addition several of the more progressive State Boards of Health notify other health jurisdictions of cases of reportable diseases developing within their bounds in recent arrivals from these outside jurisdictions. By this means sources of infection frequently unknown to these authorities are revealed.

7. Investigation of Cases Reported or Discovered.—It should be the purpose of every health officer to endeavor to discover the source of infection responsible for every case of disease recognized. This can only be accomplished by an epidemiological investigation of every case reported immediately upon receipt of the report, simultaneously with the inauguration of appropriate control measures. The investigation should have the following scope in order to reveal the desired information, and of course its scope will vary depending upon the routes of transmission possible with different infective agents. The information sought should include:

(*a*) *Clinical Data.*—Previous attacks of the same disease, date first felt ill, date took to bed, date diagnosis achieved, date of recovery or death, and other special information illuminating these points.

(*b*) *Possible Sources of Infection or Routes of Infection Encountered.*—Contact: Exposure to known or suspected cases, other similar cases at school or place of employment, similar cases in the same neighborhood etc., or in the same family, household, or among other associates; travel; social activities etc.

Water, milk and food consumed. Usual and unusual sources of supply, at home, place of employment, school, or travel etc. Where unusual sources of supply are ascertained, particular endeavor must be made to localize the date of their consumption.

Flies and other insects in relation to a possible source of infection as well as from the standpoint of further dissemination of infection from the patient.

(*c*) *Opportunities for Further Spread of Infective Agents from the Patient.*—Susceptibles in contact with patient from the probable beginning of his infectivity; the dates upon which isolation and concurrent disinfection were begun; the dates upon which they ceased; and the hygiene and sanitation of the patient's dwelling.

A form used for the investigation of typhoid fever is shown on pages 87–90.

Upon the scope and detail of the interrogations will largely depend the success of the investigation in revealing the probable source and route of infection. When all information is gathered from the several cases of an epidemic it must be subjected to a statistical analysis to secure information relative to the route of infection involved and the probable source of infection. The investigation will also result in the discovery of missed cases.

THE STATE UNIVERSITY OF IOWA

LABORATORIES
FOR THE
STATE BOARD OF HEALTH

EPIDEMIOLOGICAL DIVISION

Intestinal Infections Inquiry

Case No................

Town ....

Date of interview.......

Informant ....

Disease ....

(1) IDENTIFICATION DATA

Name?..Age?............Sex?...........

Nationality?..........................Residence when taken sick?..........................

From................to.....................Previous residence?............................

Occupation?..................................Place of business?............................

How long?........................Institution attended?.....................................

How long?..................................Removed to hospital?...........................

Name and location?...

Date reported?...........By whom?.............................Address?.....................

(2) CLINICAL DATA

Previous health?..........................Previous attack of same disease?....................

Date first felt ill?.......................Nature of earliest symptoms?..........................

....

Date stopped work or school?.........................Date took to bed?........................

Date first seen by a physician?...

Nature of onset?..

Temperature?..................Rose spots?................Enlarged spleen?...................

Diarrhoea?.................Character of stools?..

Frequency?...

Results of Widal?.....................White count?......................................

Results of bacterial examination?..

Condition and other symptoms?..

....

Diagnosis?...When made?.........................

Received typhoid vaccine?..............................When?................................

Date complete convalescense?..........................Date death?.............................

(3) SOURCES OF INFECTION

(A) Personal associations:

(a) No. of members in family?..............No. of occupants of house?..........................

Those who have had typhoid (etc)? When?

....

....

(b) Deaths in household during past year and cause?..

....

(c) Newcomers in household within 3 months?

....Where from?...........................

....

Have any of above had typhoid (etc)?......................When?................................

....

(d) Servants in household?..............No.?..................Names?........................

....For how long?................

Home residence?..................................Typhoid (etc) in their home?.............

Previous attack of typhoid (etc.) in previous places of employment?...............................

....

(e) Has patient been in contact with:—

A known case?...
A suspected case?...
A case of prolonged fever?..
A convalescent case?..
With persons in contact with typhoid (etc)?..

(b) Sanitation of Residence 30 Days Prior to Illness:

Character of residence?..Sewered?..............

Water closet? Inside—outside—location?..

Privy?........................In use?.......................Condition of superstructure.......

....

Condition of vault?...

Disposal of night soil?...................................Well on premises?....................

In use?......................Relation to privy?...

Condition?..

House screened?.............Flies present?..

Relative abundance?......................**General impression of Sanitation of premises?**...........

....

Previous case of same disease in house?........................**When?**...........................

Previous case of same disease in neighborhood?........................**When?**........................

(c) **Water used within 30 days prior to illness:—**

Solely?..................................**Where?**..

Principally?..............................**Where?**..

Occasionally?.............................**Where?**..

That used at place of business or institution attended?..

Ice how used?....................**Source?**..

Soft drinks?......................**Where?**..

Others in family using same water?...

(D) **Dairy products used for 30 days prior to illness:**

Milk used: as a beverage?....................**In tea, coffee or cocoa?**.....................

On cereals?...................................**Boiled or pasteurized?**.......................

Source?.......................................**Loose or bottled?**...........................

Other sources?..

Ice cream?....................................**Source?**.....................................

Butter?.......................................**Source?**.....................................

Separate purchases of cream or butter milk..............................

Others in family using same dairy products?...

(E) **Other food:..Meals where taken:**..

Solely?...

Principally?...

Occasionally?...

Banquets, picnics, excursions or other gatherings attended where food, milk or water consumed?

Celery?..........**Source?**..........**Lettuce?**............**Source?**............**Radishes?**............

Source?............**Oysters, etc?**............**Source?**................**Cold meats?**................

Salads?..**Source?**............................

....**Other foods?**...

Others in family who partook of same food?...

Delicatessen foods eaten?..................**Source?**.................**Nature?**................

....

Do servants eat same food as family?...

(7) Out-of-town (with-in-town) trips within 30 days prior to illness:

Where to?.................................. ..When?.........................

Route taken?..........................Stops?..

Meals taken?..........................Water?..................Milk?................

What else eaten?...

Place stopped at?...................... Sanitary condition?............................

Places visited?...

Where to?...........................When?..

Route taken?...........................Stops?..

Meals taken?........................... Water?..................Milk?................

Place stopped at?.......................Sanitary condition?............................

Places visited?...

Known contact at these places?...

Others of family who made same trips?...

Bathing or swimming?...

(4)..CONCERNING FURTHER SPREAD

Did patient continue at usual work while feeling ill (milk and food handlers)?............. ....

Disposal of discharges during this period?...

Antityphoid vaccination of contacts?...........................No?...........................

Date of beginning precautions against spread?..

Isolation of patient?.......................Effective: Non-effective? Disinfection of feces?......

.......................Urine?..

Manner of disposal of excreta at present?...

Screening of patient's bedroom?...............Other prophylactic measures?.......................

....

Nurse: trained or lay?...................Name..

Date of relaxing precautions?.........................Condition of infectiveness or discharge?...

....

....

....

....

Investigator.

8. **Analysis of Epidemiologic Data.**—In undertaking such an analysis it is important to locate the cases both from the standpoint of place and time, as this will yield important information.

First however, the imported cases should be excluded from the analysis. A case is regarded as if imported if either (a) brought into the local area while ill, or (b) if out of town at at the probable time infection was received. The principal consideration they should receive will relate to their potentialities as a local source of infection.

To localize the cases from point of space they should be plotted upon a map of the district according to their place of illness at the time of onset. One should then note if their distribution is localized or generalized, and if it has any definite relation to possible neighborhood activities, or water or milk supplies. From the standpoint of time the case should be plotted upon co-ordinate paper according to their dates of onset. From the curve thus secured one should note whether the course of the epidemic is abrupt or explosive in its rise and fall, or slow and gradual. The former curve indicates that the cases owe their infection to the use of some common route of infection, such as water, milk, etc., in other words that their infection has been simultaneous. The slow rise and fall of the curve indicates contact transmission or fly transmission.

The contact transmitted diseases with short incubation periods and great virulence, such as influenza, will produce an epidemic curve much more abrupt than that produced by the other diseases of this group, having longer incubation periods.

If the curve is explosive, analysis of the data secured under the heading of probable routes of infection, should be made to ascertain the route of infection common to all cases, at least those of the explosive period. When ascertained this must be further investigated to reveal the source from which the route became contaminated.

On the other hand, if the outbreak had a slow rise and fall the contact histories will for the most part link up with one another, excepting for gaps produced by transfers of infective agents from unrecognized infective persons. Epidemics due to different types of routes of infection have certain peculiarities, to which attention will be called when considering these routes in detail.

As soon as the infected route of transmission is ascertained proper measures to render it innocuous must be immediately

inaugurated. When this is done the epidemic will draw to a close except perhaps for a few scattered contact cases.

The probable time of infection is reckoned by subtracting the average incubation period from the date of onset.

9. **Emergency and Routine Epidemiology.**—Emergency epidemiology is the application of the principles presented in the foregoing paragraphs and chapters in the face of the emergency produced by an epidemic, and epidemics usually result from a deficient or inadequate public health organization. The work is usually done in the face of the epidemic, actually at a time when the danger is at a maximum or tending spontaneously to decline. The remedial measures employed are usually of a temporary character, aiming principally at a control of routes of infection rather than sources.

On the other hand, the routine application of the foregoing methods day after day to each case of communicable disease recognized, will soon show results in a reduction of both morbidity and mortality, and extensive epidemics will be prevented. Small epidemics may occur due to unrecognized importations of infection, but these will not have a chance to spread. This is routine epidemiology, which not only aims at a permanent control of the routes of infection, but of the sources as well.

10. **Education of the Public in General Cleanliness.**—The education of people in personal hygiene will do much to prevent the spread of diseases, as well as secure their co-operation with health officials. The following points in general cleanliness are of special importance in this connection:

(*a*) Washing the body frequently with soap and water.

(*b*) Washing the hands with soap and water after voiding the bowels and bladder, and always before eating.

(*c*) Keeping the hands and unclean articles, or articles that have been used for toilet purposes by others, away from the mouth, nose, eyes, ears and vagina.

(*d*) Avoiding direct exposure to the spray from the noses and mouths of people who cough and sneeze, or laugh and talk loudly or in an explosive manner.

(*e*) Avoiding the use of common or unclean eating, drinking, or toilet articles of any kind, such as towels, hair brushes, drinking cups, pipes etc.

(*f*) In epidemic periods public assemblages should be discouraged and the wearing of masks should be encouraged.

(*g*) Promiscuous spitting should be prohibited.

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CHAPTER XII

DISINFECTANTS AND DISINFECTION

The importance of disinfection in connection with isolation permits this subject to be considered to best advantage at this time.

Disinfection may be defined as the destruction of infective agents where ever they may be; while disinfectants are agents capable of producing disinfection. Disinfection is not necessarily the same as sterilization, by which process we mean the certain destruction of all forms of life.

1. **Disinfectants in Relation to the Body.**—In relation to the body disinfectants may be either internal or external.

(*a*) Internal disinfectants are employed chiefly as therapeutic agents, though some endeavor has been made to employ them in the sterilization of carriers. Their employment is the basis of specific therapy as applied to infection. As examples one may site the employment of mercurials and arsensicals in syphilis, of quinine in malaria, of ipecac in amœbic dysentery and ethyl-hydro-cuprein in lobar pneumonia.

(*b*) External disinfection is the practice in which we are at present interested. It is employed upon infective agents without the body under the following circumstances:

1. As they leave the body in the infective secretions and excretions.
2. After they have been distributed in the environment of the patient.
3. After they have gained access to their definitive (insect) host.

2. **Disinfecting Agencies may be Either Natural or Artificial.**—We may perhaps best consider them according to whether their action is physical or chemical.

(*a*) *Physical Disinfectants.*—The natural agencies of disinfection are for the most part physical in character and commonly their importance is sadly ignored. Their efficiency is undoubtedly the principle reason for the salvation of most higher organisms from the ravages of the lower parasites, as witness the extraordinary numbers of these which are dis-

charged from the infected host while so few succeed in reaching a new host. Most of these countless parasites are doomed to certain destruction by these natural agencies (see Table II, page 30). The physical agencies include the following:

1. Dessication.

2. Heat, either in the form of dry or moist heat, or complete incineration. Moist heat may be artificially employed either as boiling water, streaming steam, or steam under pressure.

3. Light: particularly sun light, and of the sun's rays the ultra-violet are those of greatest bactericidal action.

(*b*) *Chemical Disinfectants.*—Most of the artificial methods, particularly these employed in connection with medical asepsis in isolation are of this group. These are either:

1. Liquids, which in turn are either:

Solutions, such as bichloride of mercury, phenol, formalin, iodin, chlorin, bleach, etc., or suspensions, such as the cresol compounds.

2. Gases, such as sulphur dioxide or formaldehyde. The employment of gaseous disinfectants is known as fumigation.

3. **Manner of Action.**—Different agencies exert their lethal action in different ways. Some of the lethal effects are known, but our knowledge of the means of their action is obviously incomplete. Among these we may consider the following:

(*a*) Abstraction of water, *i.e.*, dessication. This may be lethal to some organisms, or cause others to enter upon a condition of suspended activity.

(*b*) Coagulation of the protein of the micro-organisms, either with or without an ionic poisoning of their protoplasm. The first is produced by the action of metallic salts, while such agencies as phenol do not produce an ionic poisoning.

(*c*) Destruction by emulsoid action. The lethal effect is due to a molecular bombardment of the micro-organism by the finely suspended particles, associated with a certain amount of poisoning through absorption.

(*d*) Oxidation of the protoplasm, such as that produced by ozone, chlorine, or the permanganates.

4. **Standardization of Disinfectants.**—Accurate comparisons of the efficiency of disinfectants, particularly of their efficiency under conditions of actual employment is very difficult, due to the absence of suitable standards. Laboratory experimentation together with empirical experience has demonstrated the effectiveness and reliability of the disinfectants in the dilutions later named. It is when one is called upon to express an opin-

ion as to the use of some proprietary preparation of uncertain strength and composition, that the greatest need of such standards is felt. While some progress has been made in the comparison of the relative efficiency of these substances, the question of standarization is still far from settled. This is chiefly due to the great number of factors which influence the activity of disinfectants, the different conditions under which they must act in practical employment, and the species of infective agent upon which they may have to act. The most important advance in this direction was the method introduced by Rideal and Walker, of which other recent methods such as the Hygienic Laboratory method are modifications. In the determination time of action and temperature of exposure are arbitrarily taken as constants and the strength of the disinfectant solutions as the variable. Phenol has been chosen as an arbitrary standard. Cultures of *B. typhosus* in broth have commonly been employed as the test organism. In practice varying dilutions of the standard phenol are compared with varying dilutions of the unknown disinfectant being tested, until dilutions of the two are found which kill after the same period of exposure, usually arbitrarily taken at seven minutes. The results are expressed by dividing the lowest dilution of the unknown by the lowest dilution of phenol which killed in the same space of time. The result is called the carbolic coefficient of the unknown. A low carbolic coefficient, expressed as a number less than unity, usually means the substance possesses slight disinfecting value. On the other hand, the possession of a high coefficient does not necessarily mean a substance is suitable for practical use. Other factors must be taken into consideration.

5. **Properties of an Ideal Disinfectant for External Use.** We can specify certain properties which an ideal disinfecting substance should possess, but unfortunately we possess no disinfectant in which all these properties are simultaneously present. They are the following, and their importance is self-evident:

(*a*) It should work effectively, *i.e.*, disinfect, with or without the presence of organic matter.

(*b*) It should be reasonably stable from a chemical standpoint.

(*c*) It should be soluble or miscible in water.

(*d*) It should be harmless to man or higher animals while highly toxic to micro-organisms.

(*e*) It should possess great powers of penetration.

(*f*) It should not corrode metal, bleach pigments, or rot fabrics.

(*g*) It should be commonly available at a reasonable price.

(*h*) It should be effective against all infective agents.

6. **Conditions Influencing the Efficiency of Disinfectants.**—(*a*) Strength of solution employed: As a general rule the activity of disinfectants is directly proportional to their concentration, while very potent substances may be so highly diluted that they are without effect.

(*b*) The length of time in which they are permitted to act: No disinfectant, with the possible exception of incineration, is instantaneous in its action on all the infective agents present in a given medium. An appreciable length of time must elapse for its effect to be achieved.

(*c*) Certain agencies exert what is known as a selective action. That is they are lethal for some micro-organisms but without action on others. Therefore one must use a certain amount of discretion in the selection of a disinfectant for the destruction of a given parasite.

(*d*) The material to be disinfected may influence the results in several ways. First, organic matter may afford a mechanical protection for the infective agents and thus defeat our purpose, or there may be a chemical combination between the disinfectant and other substances present, as a result of which the effective quantity of our agent is seriously reduced. Or lastly, the material may contain resistant stages of the micro-organisms, such as spores, which are not readily affected by the agencies of disinfection selected.

While it is theoretically possible to estimate the necessary quantities of disinfectant to apply in any given case, yet in practice it is difficult to estimate the effect of the foregoing factors, since they are extremely variable. Hence in practice disinfectants must be employed in excess quantities.

7. **Technic of Concurrent or Concommitant Disinfection.** The number of substances suitable for the purpose is not large, if we select those which most nearly possess our ideal properties. The following solutions may be considered standard.

(*a*) For the disinfection of feces and urine the following may be used:

1. ***Formalin*** in 10 per cent. solution. Mix equal volume of this solution with the excreta and allow to stand for one hour. This is very effective, but the irritating fumes prevent its use in the sick room.

2. *Phenol* in 5 per cent. solution. Mix equal volume of this solution with the excreta and allow the mixture to stand for one hour.

3. *Unslaked Lime.*—Add a quantity of unslaked lime of approximately equal volume to the excreta and mix well by means of a small stick. Cover with 1 to 2 quarts of boiling water and allow the mixture to stand for two hours. This is one of the cheapest methods.

4. *Chlorinated lime*, in 3 per cent. solution. One must be sure that the preparation is fresh, otherwise its strength will be greatly reduced by loss of the chlorine. Mix equal volumes of excreta and the solution and allow to stand for one hour.

5. *Liquor cresolis compositus* in 2 per cent. solution. This is one of the cheapest and best substances for this purpose. Mix equal volumes of the excreta and disinfectant and allow to stand for one hour.

6. The foregoing will prove satisfactory for the destruction of bacterial infective agents in the feces, but will not destroy protozoan parasites or helminth ova. According to Dr. C. W. Stiles either 3 per cent. sodium hydroxide or four tenths per cent. sodium dichromate may be used to destroy protozoan parasites or helminth ova. Most species are killed relatively soon by this treatment, but the ova of *Ascaris* or *Oxyuris* may require from four to six days exposure before they are destroyed.

(*b*) For the disinfection of discharges from the mouth and nose.

Undoubtedly the simplest method of handling these secretions is to collect them on old rags or paper napkins, or in sputum cups, and incinerate these when filled. When using cloths or napkins the patient shuld be instructed to carefully fold in the contaminated area so that contamination of the fingers is reduced. Any of the substances recommended for the disinfection of feces and urine may also be used.

(*c*) For the disinfection of bed linen and clothing, bed pans and other contaminated objects, immersion for one hour in the foregoing solution of chlorinated lime or *liquor cresolis compositus* is satisfactory.

Dishes should be received into a dish pan kept for this purpose, covered with water and boiled before washing. Food remnants should be incinerated.

8. **Employment of Fumigants.**—These are most commonly employed in connection with terminal disinfection. Various proprietary generators are on the market for the liberation of

both formaldehyd and sulphur dioxid, but the only advantage that may be credited them is that of convenience. Most of these proprietary formaldehyd generators liberate the gas from paraformaldehyd or paraform, the solid polymer of formaldehyd.

(*a*) *Formaldehyd* is the most satisfactory fumigant available. Successful results depend upon the rapid liberation of the gas from either formalin, (its 40 per cent. aqueous solution) or solid paraformaldehyd. It accomplishes a surface disinfection and kills spores, though its action on them is slow and uncertain. It does not tarnish or corrode metal or bleach pigments. It is not an insecticide. For successful results proper conditions of heat and moisture are necessary. The quarters to be

FIG. 7.—Flaring top tin bucket for generating formaldehyd by the permanganate method. Height 15 inches, diameter 10 inches at base, 15 inches at top of flare. (*From Register "Fever Nursing."*)

disinfected must be maintained at a temperature of 65 degrees F. or higher and the relative humidity must be 60 per cent. or higher. The following methods may be used for its liberation:

1. Spray the formalin upon moistened sheets spread out over stretched lines. Use at least eight ounces of formalin for every 1000 cubic feet in the apartment. One ordinary bed sheet, when previously moistened, will retain this amount of the formalin. The gas is liberated by the evaporation of the water. This is the simplest and cheapest method available.

2. The liberation of formaldehyd by means of potassium permanganate.

(*a*) This method was widely employed when potassium salts were cheap. A deep flaring can, or a large crock or jar is put in a tub in the apartment to be disinfected (Fig. 7). In the crock is placed 250 grams of potassium permanganate for every 1000 cubic feet of space and when preparations are completed there is poured over this 500 c.c. of 40 per cent. formalin diluted with an equal value of water, for every 1000 cubic feet of space. The operator then makes a hasty exit. The crock and tub should not be placed near any draperies and the floor about

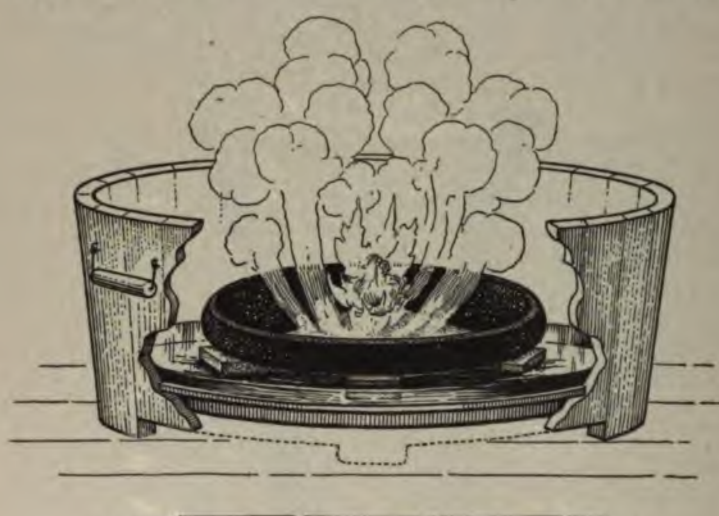

FIG. 8.—Showing the pot method of burning sulphur.

the tub had best be protected by paper. The gas should act for at least 8 hours.

(*b*) *Sulphur dioxid* is a poorer germicide than formaldehyd, but is a good mammalicide and insecticide. It posesses several disadvantages, namely it tarnishes and corrodes metals, bleaches pigments and rots fabrics. However it is cheap and readily obtainable. The actual disinfection is accomplished by sulphurous acid, for whose formation water vapor is necessary. Consequently attention must be given to humidity conditions, although moisture is not necessary when it is used as an insecticide. For disinfecting purposes 5 pounds of sulphur for every 1000 cubic feet are required. This is equivalent to 5 per

cent. of gas, the maximum concentration possible in the air. For every 5 pounds of sulphur employed one pound of water should be vaporized. It is germicidal in from 6 to 24 hours. For the destruction of insects 2 pounds of sulphur per 1000 cubic feet are sufficient. It should act from 2 to 12 hours when used for this purpose.

FIG. 9.—For purpose of fumigation all cracks around doors and windows except the door of exit should be sealed with adhesive paper.

Sulphur dioxid is most commonly and conveniently generated by the burning of sulphur. Ordinary stick sulphur is crushed to fineness and the required amount is placed in a conical pile in a shallow cast iron pot or jar, which is supported on bricks in a tub containing 1 to 2 inches of water (Fig. 8). A small

conical depression is made in the top of the pile and in this is placed a small ball of waste saturated with alcohol. The alcohol is ignited and its burning is sufficient to ignite the sulphur. It is important that the pots employed be shallow.

(*c*) *Preparation of Quarters for Fumigation.*—All cracks around doors and windows except the door of exit should be

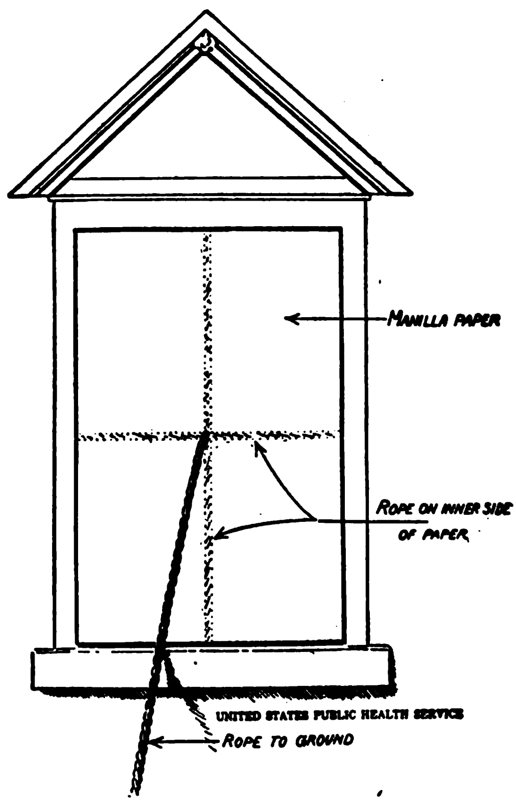

FIG. 10.—Detail of preparation of window for rapid ventilation after fumigation. (*From Trask: Suppl.* 15, *P. H. Rep.*)

sealed with adhesive paper, but the lower windows should not be locked (Fig. 9). Open all closet doors and bureau drawers. When the mixture of the reagents is set off, immediately leave by the unsealed door and seal this from the exterior. When the required period of exposure is completed, the ground floor windows can be opened from the outside and ventilation established. The quarters should be thoroughly aired before they

are entered. When an entire home or building is to be fumigated, ventilation after the completion ot fumigation will be facilitated by the sealing of the upper story windows in the manner illustrated in Fig. 10, by which means they can be opened from the ground.

9. **Insecticides.**—The employment of these will be considered later.

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CHAPTER XIII

EXCRETA DISPOSAL

The term excreta is a collective one, applied to both human feces and urine. These discharges have a direct relationship to health for the following reasons:

(*a*) Several different species of infective agents leave the body by this means, from which they may be transmitted to other persons by the agencies of contact, contamination of water supplies with excreta, and by the contamination of house flies with excreta.

(*b*) In addition, lack of care in the collection and removal of these discharges will give rise to collections of decomposing organic matter about habitations, which are exceedingly offensive to the senses. In other words, it then constitutes a nuisance.

1. **Modern Urban Methods of Excreta Disposal.**—The necessity for these methods has arisen from the extreme congestion of urban population which characterizes the present era. Urban sewer systems were originally devised for the removal of storm and ground water, not for the removal of excreta. Thus not until 1815 was fecal matter permitted in the London sewers, in 1833 in Boston and in 1880 in Paris. Water closets as we know them, date from the report of the English Health of Town's Commission in 1844 and were not connected with sewers until 1847. The successful employment of water closets requires that an abundant supply of water under pressure be available, inasmuch as the solid fecal debris is transported in the sewers, particularly the house drains and lateral sewers, by the velocity of the water current. Hence the present system of excreta removal widely employed in our cities and towns is known as the water carriage system.

2. **Sewerage.**—Sewerage is the term applied to the underground system of drains by which excreta is removed inoffensively. While the development of such systems has relieved a certain set of sanitary problems by removing these offensive accumulations from around urban dwellings, yet the transportation of the excrement of an entire city without its bounds, and

its concentration at one or a few points has given rise to an entirely new set of problems, which we shall consider later.

In a consideration of a sewerage system certain terms are used, which we will define here:

(*a*) A combined sewerage system is one that receives both domestic sewage as well as the surface wash of the streets, known as storm water.

(*b*) Sanitary sewers are those that receive domestic sewage alone.

(*c*) Storm sewers are those that receive storm water or street washings alone.

The last two systems are the best where methods of sewage treatment are employed, inasmuch as the large volumes of storm water interfere seriously with the operation of the sewage disposal plants.

A sewerage system consists of the following components, the names of which are self explanatory. Starting at the dwellings we have the house drains, which discharge into the lateral sewers, which in turn discharge into the trunk sewers, which carry the excreta to the point of disposal. Trunk sewers may be connected to intersecting sewers which carry the excreta still further away.

3. **Sewage.**—Sewage is the material which flows through the sewers. It consists of the waste water supply, plus ground water leakage into the sewers plus domestic water wastes, plus excreta, plus industrial wastes and perhaps storm water in addition. In dry weather its volume approximates the daily water consumption of the community. Per capita its daily volume in small towns will be from 40 to 50 gallons, in large cities from 100 to 200 gallons. Per capita its average composition will be about the following:

Average daily water consumption	285,000 gms.
Fecal solids	100 gms.
Urinary solids	50 gms.
Miscellaneous solids	500 gms.

From the standpoint of its composition we may consider sewage to be a more or less homogenous suspension of fine particles with organic and mineral matter in solution. The organic matter present is very unstable so that its chemical composition is variable, depending on the age of the material. Important organic constituents are urea, albumen, fibrin, casein,

starch, sugar, fats, and soaps. Of the elemental substances present nitrogen and sulphur are of the greatest importance.

4. **Sewage Disposal by Dilution.**—The large volume of water present demands that economical transportation be effected by gravity, and that it be discharged into some convenient water course. The discharge of the untreated sewage into some

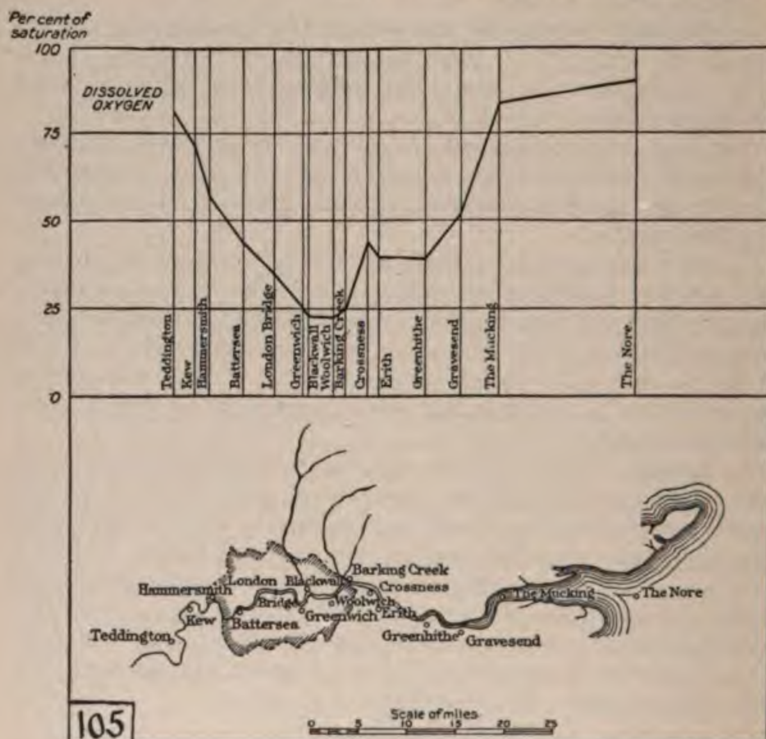

FIG. 11.—Diagram illustrating self-purification in the Thames, England. The discharge of the large volume of sewage from London soon markedly lowers the dissolved oxygen, which however is restored by the time the water reaches the river's estuary. (*U. S. Geological Survey, W. S. Paper* 185.)

water course is known as disposal by dilution. It has given rise to a series of problems, arising from nuisances and the contamination of public water supplies, from which have developed the modern methods of sewage treatment and water purification.

If the body of water into which the raw sewage is discharged is of sufficient volume, disposal by dilution may be sufficient.

On the other hand, if the diluting body is of insufficient volume, or if drinking water supplies are contaminated, or oyster beds are contaminated, or a nuisance is produced, it is unsatisfactory or even dangerous.

When the process is satisfactory the following events take place:

(*a*) There is a sedimentation of the heavy particles.

(*b*) There is an oxidation of the organic matter into stable and inoffensive substances by bacterial activity through the dissolved oxygen in the water (Fig. 11).

(*c*) There is a gradual destruction of the fecal bacteria due to their introduction into an unfavorable environment and the activity of predatory protozoa.

Where a stream receives sewage we find that for a distance of several miles below the sewer outfalls, definite evidence of the sewage contamination is observable, but that at a greater distance the stream bed and the water assume an appearance similar to that above the entrance of the sewage and its appearance is no longer offensive. This phenomenon, due to the above agencies, is known as the "self purification" of streams.

Where dilution is insufficient we find that the sedimented material and dissolved matter does not undergo oxidation, but, due to insufficient oxygen, undergoes anaerobic decomposition with the production of offensive gases and odors; that the dissolved oxygen is consumed and fish life cannot survive.

Factors which limit the successful operation of this method of disposal are the following:

(*a*) The sewage should not greatly exceed 1 per cent. of the volume of the water into which it is discharged, though this factor varies directly with the rapidity of the stream, since reoxygenation is more speedy in rapid streams.

(*b*) The amount of dissolved oxygen in the water, which is greater during cold periods than in warm weather. It must be remembered that the capacity of salt water for dissolved oxygen is about 20 per cent. less than fresh water.

(*c*) The rate of the dispersion of the sewage in the diluent. This must be quick.

5. **Sewage Treatment.**—When satisfactory disposal by dilution cannot be secured, the treatment of the sewage is necessary. The following results are sought:

(*a*) A separation of the suspended matters (sludge) from the liquid sewage.

(*b*) The destruction of the putrescible organic matter in the liquid sewage preparatory to its final mineralization by oxidation (non-putrescibility).

(*c*) The transformation of the sludge into a stable and inert condition, with or without the aid of oxidation.

(*d*) The destruction or removal of bacteria from the effluent.

Several methods are employed to secure the above results which are used either singly or in various combinations. Great care and judgement must be employed in selecting the method of treatment to be employed, since different methods of treat-

FIG. 12.—Fine mesh revolving screen at Birmingham, England. (*Courtesy of J. D. Watson.*) These screens constantly revolve so that a fresh surface is always ready for use. (*Am. Mus. Nat. Hist., Guide Leaflet*, 33.)

ment vary in the degree of their successfulness, depending upon the character and composition of the sewage to be treated, as well as the degree of attention paid to the care of the disposal plants. All sewage treatment plants require intelligent operation, together with some degree of skill. Most dissatisfaction or failure can be traced to either neglect or ignorant operation. Sewage treatment plants should be designed by competent sanitary engineers, after study and experimentation has revealed the method of treatment best suited to handle the local sewage.

6. **Preparatory Processes.**—These are designed to effect a separation of the suspended matter or sludge from the liquid sewage.

(*a*) *Screening.*—Coarse or fine gratings or screens are placed across the path of the sewage to remove coarse material, which is removed from the screens at frequent intervals and either buried or burned (Fig. 12).

(*b*) *Sedimentation.*—Most of the suspended matter is removed by sedimentation. The velocity of the stream of sewage is lowered and as a consequence the fine suspended particles settle. Various means are employed to apply this principle. Among them are the following:

1. *Grit Chambers.*—These are small chambers, in which the velocity of the sewage is but slightly reduced, so that only the

FIG. 13.—Septic tank or modified sedimentation basin. Photograph of a model in the American Museum. (*Am. Mus. Nat. Hist., Guide Leaflet* 33.)

heavier of the suspended particles settle out. Because of their size the period of sedimentation is brief. They are chiefly used to effect a removal of sand and gravel in combined sewerage systems. These chambers must be cleaned frequently.

2. *Plain Settling Tanks.*—These are large basins in which the sewage is retained from one to twelve hours. The sludge is removed frequently and is not permitted to undergo decomposition in the tank (Fig. 13).

3. *Septic Tanks.*—In construction these tanks are similar to the foregoing and differ only in the method of their operation. The low velocity of the sewage in passing through the tank results in its detention for 8 to 24 hours, so that practically all of the suspended matter is deposited. This is permitted

to accumulate at the bottom of the tank for long periods, where, in the absence of free oxygen, it undergoes anaerobic decomposition. As a result of the decomposition the volume of the sludge is very much reduced. Bubbles of gas from the decomposition changes in the sludge, may bring extensive masses of sludge to the surface where it floats as a scum several feet thick. Removal of the sludge is generally only undertaken when such a volume has accumulated so as to seriously reduce the capacity of the tank (Fig. 14).

FIG. 14.—Septic tanks, Columbus, Ohio. Twenty million gallons of sewage a day can be treated in this recently constructed plant. (*Am. Mus. Nat. Hist., Guide Leaflet* 33.)

4. *Two Story Digestion Tanks.*—Several different designs of digestion tanks belong to this group, of which the best known are the Imhoff tanks. From their construction the sludge is permitted to settle in a lower chamber, where it undergoes anaerobic decomposition out of contact with the fresh flowing sewage. As a consequence the effluent of these tanks is less offensive, and the digestion of the sludge in the lower chamber is more complete (Figs. 15, 16).

5. *Chemical Precipitation.*—This method is of very limited application and its use is practically limited to those communities where iron wastes in the sewage render the accomplish-

ment of a precipitating reaction easy. The floculi thus formed enmesh the fine suspended particles and hasten their removal. After the reaction of precipitation has occured, the sewage is

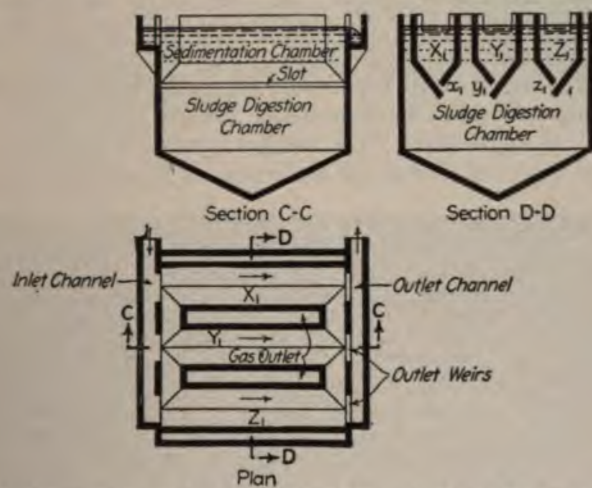

FIG. 15.—A digestion tank of the Imhoff type. Section C-C is a longitudinal view and Section D-D is a transverse view. (*After Gregory*: *Engineering Record*, 1915.)

FIG. 16.—Twin Imhoff settling tanks at Chambersburg Sewage-Treatment Plant. (*Mebus, Engineering Record*, 1914.)

run into large open tanks for sedimentation to take place. Precipitation is accomplished by the employment of lime, ferrous sulphate or alum. The principles are similar to the em-

ployment of coagulants in water purification which will be spoken of later in more detail.

6. *Activation.*—In the sedimentation chambers previously described, the decomposition of the sludge is anaerobic in character, offensive gases are produced and the stable sludge finally produced has little value. In the activation process, compressed air is admitted to the tanks through porous plates in the bottom, and as a consequence aerobic processes of decomposition are facilitated. The sludge is rapidly oxidized, is non-offensive and has considerable value as a fertilizer (Fig. 17).

FIG. 17.—Air-diffusers in sloping bottom of activated sludge tank. (*Engineering Record*, 1915.)

7. *Roughing Filters.*—These are large vats or tanks filled with coke, crushed stone, or similar material, and filled with sewage. As a consequence of the rock or other inert material present, sedimentation is facilitated, since the vertical distance a suspended particle has to pass to reach a firm support is very much reduced.

7. Sludge Disposal.—The amount of suspended matter collected in the tanks is considerable and since (except in that collected in the activation process), its value is slight or nothing, the disposal of sludge is usually considerable of a task and a problem. Digestion measures considerably reduce the volume to be disposed of, but do not altogether dispose of the sludge. The following additional measures are employed:

(*a*) Pressing the sludge in filter presses to remove the surplus

moisture. This is necessary to permit its ready handling. After a drier sludge is secured it is either:

(*b*) Used for filling low areas of land, or

(*c*). Loaded onto cars, or barges and dumped at sea.

(*d*) Some of the more stable sludges, for example those secured from the Imhoff tanks, are run off into drying beds. When dry the sludge is of loamy consistency and is then scraped off and buried in trenches.

CHAPTER XIV

EXCRETA DISPOSAL (CONTINUED)

8. Purification Processes.—These processes are designed to treat the effluent from the various types of sedimentation basins to secure a stable effluent, that is, one which is not subject to further decomposition changes. Where satisfactory most of the nitrogen will have been changed to nitrates. All depend upon active oxidation, which is secured by microbial activities. The following methods are employed to secure this result:

Fig. 18.—Intermittent sand filter bed. Photograph of a model in the American Museum. (*Am. Mus. Nat. Hist. Guide Leaflet* 33.)

(*a*) *Subsurface Irrigation.*—The effluent is intermittently discharged through one or more strings of open joint tile just under the surface of the ground. The liquid is thus discharged into the layer of soil where bacterial activities are greatest. The method is only adapted to open or porous soils, particularly under rural conditions where the volume of liquid is small. (Figs. 26 and 27). The soil must not be permitted to become water logged, otherwise aerobic decomposition will be superseded by anaerobic, and a nuisance result.

(*b*) *Broad Irrigation.*—The sewage effluent is discharged into irrigation furrows on cultivated land and permitted to percolate downward through the soil. This method is only adapted to open or porous soils, preferably in arid regions, where water for purposes of irrigation is at a premium. Under these circumstances it may pay for itself. It has not been a success in this country.

(*c*) *Intermittent Sand Filtration.*—The effluent is applied intermittently, soaks quickly away and most of the time the filter is exposed to the air. With proper operation very good results are secured. On the other hand, if too large quantities of effluent are applied, or applied too frequently, the filter becomes water logged and oxidation is prevented. Its use is

FIG. 19.—Double contact beds for purification of sewage. Photograph of a model in the American Museum. (*Am. Mus. Nat. Hist. Guide Leaflet* 33.)

practically limited to areas of sandy soil. These should be ridged for winter operation to prevent freezing (Fig. 18).

(*d*) *Contact Beds.*—These are similar in construction to roughing filters, but are operated intermittently on the fill and draw method. The suspended matter settles on the crushed stone. When the tanks or beds are full the action is septic or anaerobic, when empty the matter on the stone is subjected to aerobic or oxidative action. The beds are usually operated in series (Fig. 19).

(*e*) *Trickling Filters.*—These are concrete vats, on the floor of which are open tile drains, and above which are several feet of crushed rock, over which the sewage effluent is sprinkled or sprayed. The interstices of the rock are exposed to the air at all times when properly operated. As a consequence com-

plete aeration is secured and the effluent is stable. They are well adapted to areas where sandy soil is not available (Fig. 20).

9. Finishing Processes.—In the first three methods described above, the filtered effluent joins the ground water. In the latter two it is discharged from the beds into some water course. In order to destroy any pathogenic bacteria which have managed to pass through the treatment beds, the present practice is to sterilize the effluent by the employment of chlorine, either as compressed chlorine or bleach. The methods of application are similar to those used in water disinfection

FIG. 20.—Trickling filters, Columbus, Ohio. By means of fixed sprinkler nozzles, sewage is sprayed evenly over the surface of a bed of coarse stone. This method is at present considered one of the most effective of all devices for sewage purification. (*Am. Mus. Nat. Hist. Guide Leaflet* 33.)

where they will be discussed in more detail. The quantity applied varies with the condition of the effluent. It is also applied to raw or unsettled sewage where other treatment is not used.

10. Domestic Excreta Disposal.—We will now consider the methods of excreta disposal available for isolated dwellings, for example those in unsewered portions of cities and towns, unsewered villages, farm homes, summer resorts, and camps.

It is essential that individuals under these circumstances be sufficiently educated in personal hygiene to realize the importance (1) of having some place about the dwelling where the

excreta of all members of the household is concentrated, (2) that at the place of concentration the excreta is so cared for that it is not a further menace to their health, and (3) that modesty, decency, and cleanliness, are cultivated. Only where these are observed can soil pollution or contamination by excreta be prevented (Figs. 21, 22), and domestic water supplies be safeguarded.

The methods suitable to any given home will depend whether or not domestic water pressure is available. In the absence

FIG. 21.—An unsanitary privy of primitive type permitting extensive soil pollution. Drawn from a photograph. (*P. H. Bull.* 68. *U. S. P. H. S.*)

of domestic water pressure either of the two following methods may be employed:

(*a*) *The So-called Chemical Closets.*—These are simple installations for the interior of the dwelling, in which the excreta is received into a strong caustic solution, which disinfects the material. If properly cared for they will probably give satisfactory results (Fig. 23).

(*b*) *Privies.*—A satisfactory privy should protect the excreta from flies, rats, hens, pigs, etc., and should be well ventilated to permit the ready evaporation of the liquid excreta. Their

FIG. 22.—Typically unsanitary privy at a farm home, showing flies swarming about the privy contents. The excreta are deposited upon the surface of the ground. (*Lumsden*: *P. H. Bull.* 94. *U. S. P. H. S.*)

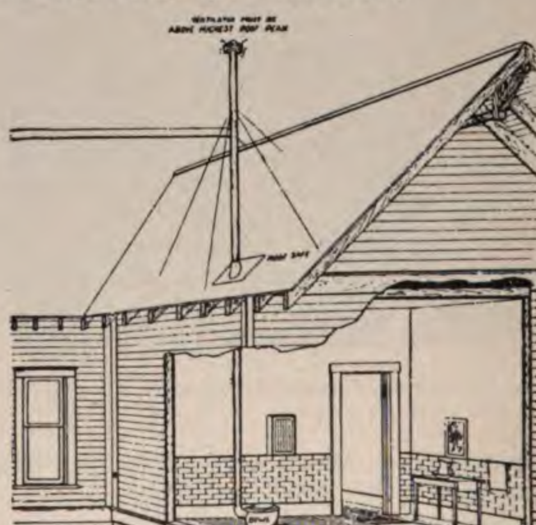

FIG. 23.—Sketch showing general arrangement of a chemical closet. (*Courtesy of the Dail Steel Products Company.*) (*Hansen*: *Illinois Health News.*)

successful operation depends upon the degree of simplicity in their construction, as a general proposition those whose successful operation requires continuous care are neglected sooner or later. All should be well screened and have a tight seat cover. Privies are usually of the following types:

1. *Vaulted.*—The excreta are deposited into a pit or vault underneath. The pit should be made water tight by means of concrete walls and bottom (Fig. 24).

2. *Pail or Can Privies.*—The excreta are deposited in large pails or buckets fitted underneath the seat. At voiding the person using the privy may cover the excreta with a thin layer of dry earth or ashes. They require constant attention, are apt to be

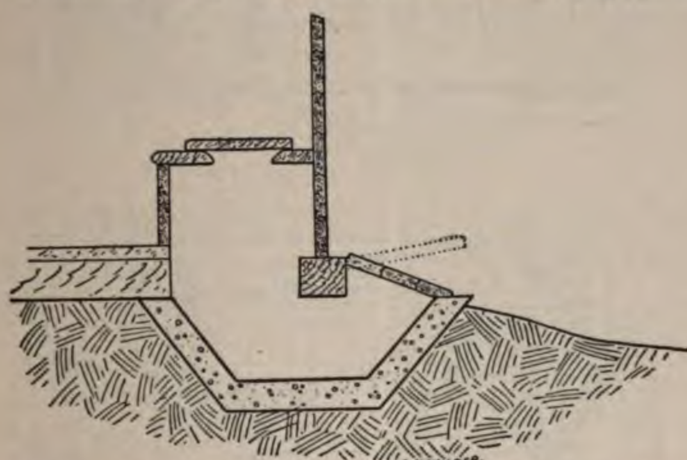

FIG. 24.—A stationary-receptacle sanitary privy with a cement vault arranged for convenient clearing. (*P. H. Bull.* 68, *U. S. P. H. S.*)

neglected and hence, if privately controlled, are troublesome (Fig. 25). The wide spread employment of this type of privy in unsewered towns, or unsewered areas of towns, should be under municipal supervision. Provision should be made for the exchange of receptacles at frequent, regular intervals, if satisfactory results are to be secured. The expense of maintainence of such a system is high, which tends to stimulate a desire for the early installation of a sewerage system. The excreta (or night soil) are disposed of either by burial or incineration.

3. *Leaching Privies.*—These are apt to be unsatisfactory or dangerous. No pit is provided and the excreta are deposited on the surface of the ground. They should be located with care

with particular reference to surface drainage and are not suitable for clay, gravely soil or limestone soils. They are not to be recommended.

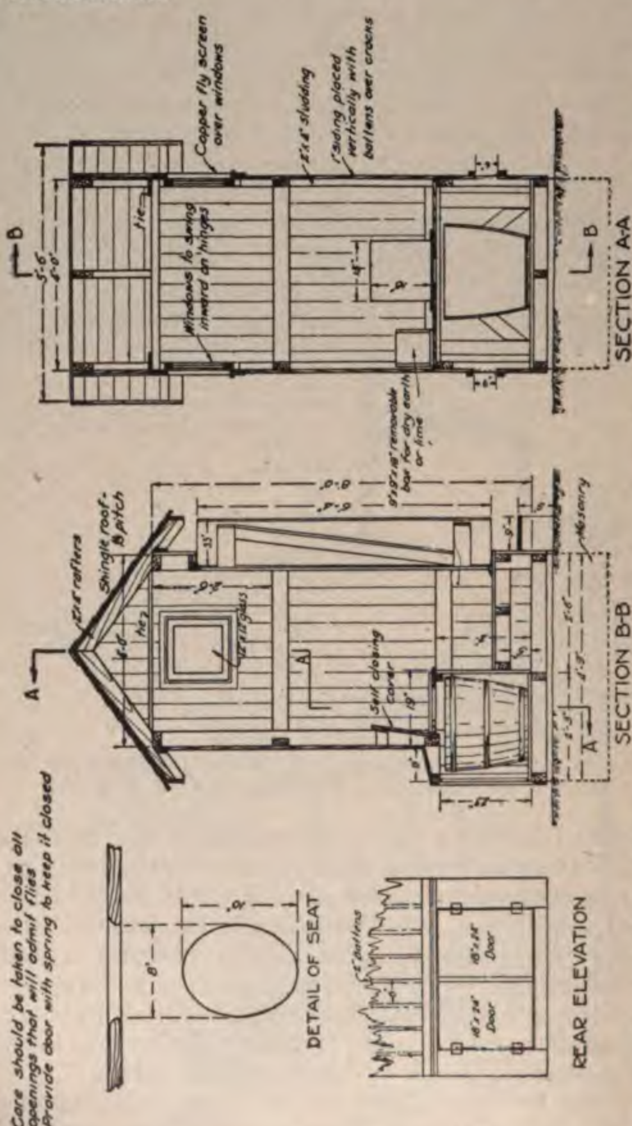

FIG. 25.—Privy with water-tight receptacles placed in an accessible position above the surface of the ground so as to avoid soil pollution. (*Hansen: Illinois Health News.*)

When domestic water pressure is available cess-pools are commonly employed. The closet is located within the house

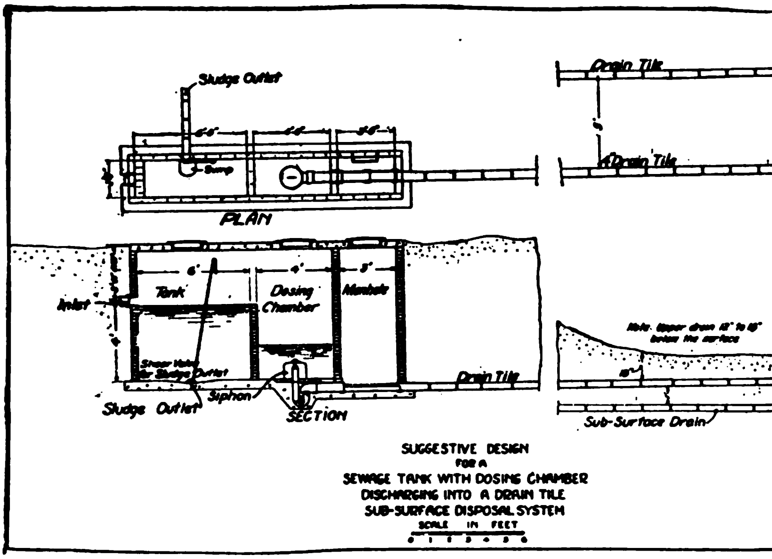

FIG. 26.—Simple form of tank built in conjunction with a dosing chamber for applying the sewage in doses on secondary treatment devices, suitable for domestic installation. See Fig. 27. (*After Hansen: Illinois Health News.*)

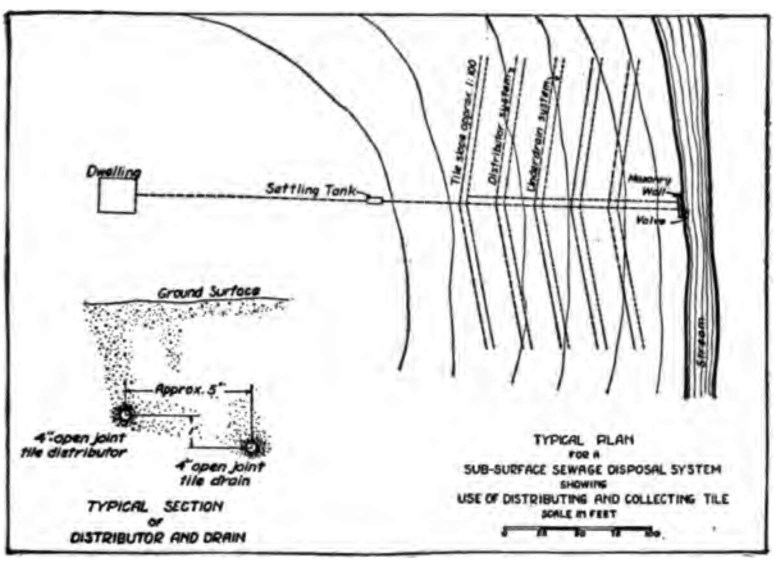

FIG. 27.—Typical plan for a subsurface sewage disposal system for domestic installation. (*After Hansen: Illinois Health News.*)

and water carriage is employed to transport the excreta to the point of disposal. These are of two main types:

(*a*) *Vaulted Cesspools*.—These have concrete bottoms, sides and top, and are in reality septic tanks. The sludge should be burned, buried, or disinfected, while the effluent is best disposed of by subsurface irrigation (Figs. 26, 27).

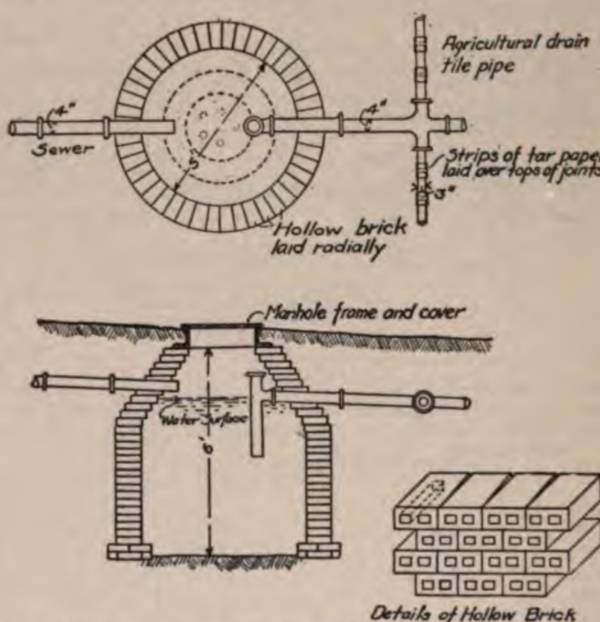

FIG. 28.—Hollow brick cesspool of the leaching type with overflow into agricultural tile. (*Horton: N. Y. State Dep't. Health.*)

(*b*) *Leaching Cesspools*.—These do not have either a tight bottom or walls. The liquid contents escape into the soil below the zone of active oxidation and hence may contaminate the ground water for some distance. They should not be used in clay or gravely soils or in limestone regions (Fig. 28).

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CHAPTER XV

THE RELATIONSHIP OF WATER TO HEALTH AND DISEASE

While water is not technically a food, it is an essential article of the diet. In addition it bears an important relationship to personal hygiene, inasmuch as it is essential in the maintenance of proper cleanliness of the person, the clothing and other objects.

1. **Relationship to Health and Disease.**—The body requires an adequate daily supply for its physiologic uses. The amount required by the male adult represents the maximum consumption for this purpose, varying from 1800 to 2100 c.c. of water ingested as such, with approximately 600 c.c. additional ingested with the solid food.

Water bears an important relationship to the communicable diseases, as it may be an important route in the transmission of several species of infective agents. The properties which make it important in this connection are the following:

(*a*) It is ordinarily consumed raw, *i.e.*, it has not been heated or otherwise subjected to any treatment that will destroy any infective agents present.

(*b*) In its normal cycle of circulation it comes in contact with a great variety of material spread over vast areas, hence if excreta be present in the open, they will be transported, together with infective agents present, by the water. Furthermore many natural sources of water supply are frequently contaminated, very often grossly so, by the direct discharge of sewage.

Water also serves as a solvent for certain inorganic poisons.

2. **Conditions which Favor the Contamination of Water and the Transfer of Infective Agents.**—Of the relationship of water to disease, that in connection with the transfer of infective agents is of greatest importance. The following conditions render the employment of a contaminated and infected water possible and probable:

(*a*) The use of water which receives the sewage of other towns; the sewage of the same town, the sewage of individual

houses, institutions or factories, or the presence of privies on or over a stream.

(*b*) The rush of floods or heavy rains which transport excreta deposited on the surface of the ground into a water course.

(*c*) The use of double supplies coupled together, one for ordinary domestic consumption, the other from an unsafe source for emergency fire protection.

(*d*) Contamination of a water shed from labor camps, railroad coaches, or excursionists.

The following factors influence the transfer of infective agents by water:

(*a*) The quick transfer of infective agents from one patient (source) to the victim in the person of the consumer.

(*b*) The probabilities favor the short survival of infective agents in water, and in addition their multiplication in water is doubtful.

(*c*) Cold water tends to prolong the period of their survival.

(*d*) The proportion of infective excreta to the volume of the diluting water is usually very small, so the dilution of the micro-organisms is enormous.

(*e*) Surface water supplies, which are most exposed to fecal contamination, are most frequently infected, while wells and springs are less often.

The foregoing factors have given water borne epidemics certain definite characteristics among which the following are the most conspicuous:

(*a*) Epidemics occur most frequently, and endemic water borne typhoid reaches a maximum during the seasonal periods (winter, fall, spring) when the water is coldest.

(*b*) Water borne epidemics have an abrupt onset, rise rapidly to a maximum and rapidly decline, *i.e.*, they are explosive.

(*c*) Investigation usually succeeds in revealing a nearby contamination and frequently the actual source or sources of infection.

(*d*) Present day evidence only indicates that water plays a role in the transmission of those infective agents which leave the body in the feces and urine, for example, typhoid, cholera, and bacillary dysentery.

Indirectly water is of importance as a breeding place for certain insects, such as mosquitoes, concerned in the transmission of other infective agents.

3. Inorganic Poisoning from Water.—Lead poisoning from water is not unknown. Lead is not found in natural water,

and when present is derived from the lead service pipes or some other lead object connected with the supply. The plumbo-solvent power of water depends upon the following factors:

(*a*) The presence of a free acid, such as carbonic acid, which is found in soft peaty waters, or,

(*b*) The presence of an excess of oxygen and little dissolved matter, such as soft water, or,

(*c*) The presence of organic matter, nitrates or nitrites, or

(*d*) The presence of chlorides, which exert a solvent power on the film of the lead carbonate coating the pipe.

The following conditions also affect the solvent power in direct proportion: the duration of contact; the temperature; the pressure; and the purity of the lead. In general one may say that turbid and hard waters have the least plumbo-solvent power.

In the new England States lead poisoning from this source is a problem to be constantly borne in mind and is usually overcome by using brass pipes instead of lead pipes.

4. Source of Water Supply.—Water is practically derived from three sources:

(*a*) *Rain water*, which is the ultimate source of all water. Practically it is of domestic importance only, in the United States. If care and attention are directed to the following points a satisfactory supply will be secured: (1) The material and care of the collecting surface; (2) Wastage of the first flow, and (3) Location and construction of the storage cistern.

(*b*) *Surface water*, including the water of streams, lakes, and impounding reservoirs. Such water is greatly exposed to contamination and its dissolved as well as suspended matter is very variable in amount. Surface water is widely utilized as a source for municipal supplies because of the vast amount available.

(*c*) *Ground water*, including the water from wells and springs. In its underground passage this water is usually subjected to a varying degree of natural filtration and is less subject to contamination. It is of importance as both a domestic and municipal source of supply.

5. The Hygienic Examination of Water.—Valuable information concerning the past history of water from a given source of supply, and hence of its hygienic value, can be secured by a physical, chemical and bacterial examination. Of still greater value than such an examination however, is a thorough inspection of the source of the supply by one competent to judge possible sources of contamination. Laboratory examinations

should be supplemental to such surveys. The following features are usually considered in a laboratory examination of water because of their direct or indirect bearing upon health:

(*a*) *Odors.*—These are in themselves harmless, but because of their offensive character result in complaints, and a lessened consumption of water. They are due to volatile essential oils liberated from the bodies of microscopic green plants (algæ), and are usually most pronounced in stagnant water containing very little or no dissolved oxygen.

(*b*) *Taste* is derived from matter in solution, either mineral or gaseous. It may render a supply unpalatable.

(*c*) *Color* is of vegetable origin and is due to material in solution.

(*d*) *Turbidity* is due to material in suspension, the water is said to be muddy. It may, if excessive, result in a lessened consumption of the water.

(*e*) *Reaction.*—The reaction of water is normally alkaline, due to the carbonates and bicarbonates of calcium and magnesium in solution. Acid waters are rare, and usually owe their acidity to either trade or mine wastes, though swamp waters may be normally acid.

(*f*) *Total Solids.*—The amount of dissolved matter in water varies widely. Quantities in excess of 500 parts per million are commonly considered to render the water unfit for use.

(*g*) *Hardness* is either temporary or permanent. Temporary hardness is due to the carbonates or bicarbonates of calcium or magnesium, while permanent hardness is due to the chlorides or sulphates of calcium or magnesium. The importance of hardness is economic, inasmuch as hard waters require a much greater amount of soap to make them suitable for washing purposes than do soft waters.

(*h*) *Organic matter* is of itself of doubtful importance, although some outbreaks of diarrhea have been ascribed to the presence of toxic substances of putrefactive origin. Ordinarily the chemical examination ascertains the scope of the changes which the nitrogenous compounds have undergone, as indicating something of the changes which have taken place in dissolved organic matter. The determination of nitrates and nitrites is considered of greatest importance. The nitrites (NO_2) suggest recent organic pollution, though if present in small quantities, their significance is slight. The nitrates (NO_3) suggest past or distant pollution. Chlorine suggests remote urinary contamination, though in interpreting these results one must

bear in mind the so-called normal chlorine, *i.e.*, the chlorine normally present in water, which is derived from sea spray or salt deposits.

(*i*) *Bacterial.*—From a hygienic standpoint the information secured by a bacterial examination of water is probably of greatest assistance and hence of greater value than any other determination. Unfortunately, since the sources vary so widely, it is impossible to establish numerical standards of the number of bacteria permissible. The greatest value of the numerical determination of bacteria in water is in the study of surface waters or in the control of purification plants. The detection of fecal bacteria is of greatest hygienic value since they give evidence of recent contamination. The group of colon-like bacilli are the chief ones sought. Their detection in ground water is of great significance, while in surface waters in quantities less than 1 per c.c., their significance is slight. Owing to their extreme dilution and for other reasons the detection of specific pathogenic organisms in water is not practicable. The detection of bacteria characteristic of feces indicates that fecal contamination is occurring, which also indicates that the excreta from an individual discharging specific infective agents might as easily gain introduction.

It is impossible to form an accurate idea of the hygienic character of a water supply from single isolated examinations. The character of raw natural waters, particularly surface waters, is subject to considerable fluctuation, while the operations of a water purification plant can only be accurately controlled by frequent routine examinations of the water. Furthermore, contamination of a supply deemed to be above suspicion may actually occur, and unless its quality is regularly followed by laboratory examination, an epidemic may be the first indication of an unnoted contamination. Such periodic routine examinations should be at least daily at water purification plants, and with untreated water from satisfactory sources, at not less than weekly intervals.

A rigid bacterial standard for potable waters is the Treasury Department standard for water furnished common carriers in interstate traffic. It is as follows:

(*a*) The total bacteria per cubic centimeter shall not exceed 100, when inoculated into standard agar and incubated at 37 degrees C. for 24 hours.

(*b*) Not more than one out of five, 10 c.c. portions of any sample shall show the colon bacillus.

A water that meets these requirements is probably from a satisfactory source, but on the other hand, the standard is so rigid that water from many safe sources of supply would be excluded.

The following are suggested by Bartow as the permissible limits for impurities in Illinois waters, expressed in parts per million (P.P.M).

TABLE IV

Characteristic	Lake Michigan	Streams (Filtered)	Springs and shallow wells	Deep drift wells	Deep rock wells
Turbidity	None	10.0	*None	*None	*None
Color	None	0.2	*None	*None	*None
Odor	None	None	None	None	None
Residue on evaporation	150.0	300.0	500.0	500.0	500.0
Chlorine	4.5	6.0	15.0	15.0	5.0–100
N as free ammonia	0.01	0.05	0.02	0.02–3	0.02–3
N as albuminoid ammonia	0.08	0.15	0.05	0.20	0.15
N as nitrates	0.04	0.5	2.0	0.5	0.5
N as nitrates	None	None	None	0.005	0.000
Bacteria per 1 c.c. 20°C	100	500	500	100	100
Colon bacillus	Absent	Absent	Absent	Absent	Absent

* None as drawn, developes on standing.

6. Water Consumption.—The water consumption in cities where a municipal supply is available under pressure in the majority of dwellings, when considered on a per capita basis is quite variable, ranging from 25 to 370 gallons and perhaps averaging somewhere near 120 gallons per capita per day. It is ordinarily considered, that per capita, common domestic uses require from ten to seventeen gallons daily. The difference in the above figures is due to the use of water in manufacturing, irrigation, and losses by wastage. In European cities the per capita consumption is much lower, varying from 24 to 69 in a number of larger cities, and perhaps averaging about 40 gallons. These figures probably represent an unduly low consumption of water, but on the other hand, the American figures undoubtedly represent a serious waste of this indespensible necessity. Our aim should be to encourage a generous use of water, but to discourage waste.

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See also the list of water supply papers of tee U. S. Geological Survey.

CHAPTER XVI

WATER PURIFICATION

1. The undesirable qualities which water may possess and the means available for their removal are presented in the following table:

Undesirable quality	Removal for industrial uses	Removal for domestic uses
(*a*) Hardness.		
1. Temporary.......	Lime and soda ash; permutit.	Boiling or soap.
2. Permanent.......	Lime and soda ash; permutit; distillation and condensation.	Lime and soda ash; permutit; distillation and condensation.
(*b*) Undesirable metals.		
1. Iron.............		Precipitation with lime and rapid sand infiltration. Aeration.
2. Lead.............		Neutralization with lime and filtration.
(*c*) Odors and tastes (Algal)..............	(see Fig. 30)	Aeration.
(*d*) Color...............	Coagulation and rapid sand filtration.	Coagulation and rapid sand filtration.
(*e*) Turbidity...........	Sedimentation, coagulation and rapid sand filtration.	Coagulation and rapid sand filtration.
(*f*) Bacterial removal....		Storage; sedimentation; rapid and slow sand filtration; domestic filters.
(*g*) Bacterial destruction.		Boiling; use of bleach; chlorine; and ultra-violet light.
(*h*) Algal destruction (see Fig. 29)...........		Copper sulphate.

Owing to limitations of time and space we will not give further consideration to the methods for the removal of hardness or undesirable metals, but only consider the others.

2. Storage.—The storage of water in large impounding reservoirs or lakes for several months effects a removal of any in-

FIG. 29.—Applying copper sulphate for the destruction of algæ at St. Paul. Note the bag containing the copper hung over the stern of the boat. (*Huff and House, Jour. Am. W. W. Ass'n.*, 1916.)

FIG. 30.—Aeration of Hemlock Lake water at Rochester, N. Y., resulting in a reduction of tastes and odors. (*Courtesy of Mr. Emil Kuichling.*)

fective agents present, by their exposure to an unfavorable environment. We have already called attention to the fact that the survival of pathogenic micro-organisms in water is but for

a short period. They are exposed to the direct action of the sun's rays and they are devoured by predatory organisms, of which the infusoria are probably the most important. One months storage under these circumstances will result in their destruction. The greatest drawback to the employment of this method is the fact that sufficient space in the shape of a reservoir is frequently not available so as to permit a city to store a month's supply, or else a sufficient reserve of water is not available to permit its aging for a month before consumption (Fig. 31).

3. **Sedimentation.**—The lowering of the velocity of a stream, such as that effected when it enters a lake or reservoir, permits the fine suspended particles to settle to the bottom. The finer the particles, the lower must be the velocity and the longer the

FIG. 31.—Lake Cheesman dam and reservoir. Denver Union Water Company. A large impounding and storage reservoir. (*Hazen: "Clean Water and How to Get It," John Wiley and Sons.*)

quiescent period before their removal is effected. This method in itself is used chiefly as a means of removing turbidity, and is of but slight value in the removal of bacteria unless the period of quiescence approximates the conditions of storage. Large open tanks or reservoirs are employed for sedimentation. Sedimentation may be employed in conjunction with the process of coagulation.

4. **Coagulation** is used in conjunction with sedimentation or as a process of treatment preliminary to rapid sand filtration. It is a necessary measure to remove the fine turbidity, particularly that produced by colloidal clay, which would not completely settle out no matter how long the period of sedimentation. Coagulation consists in the employment of cer-

tain chemicals, such as sulphate of aluminum, which react with the alkaline carbonates of the water to form aluminum hydrate. This has a large colloidal molecule and being in-

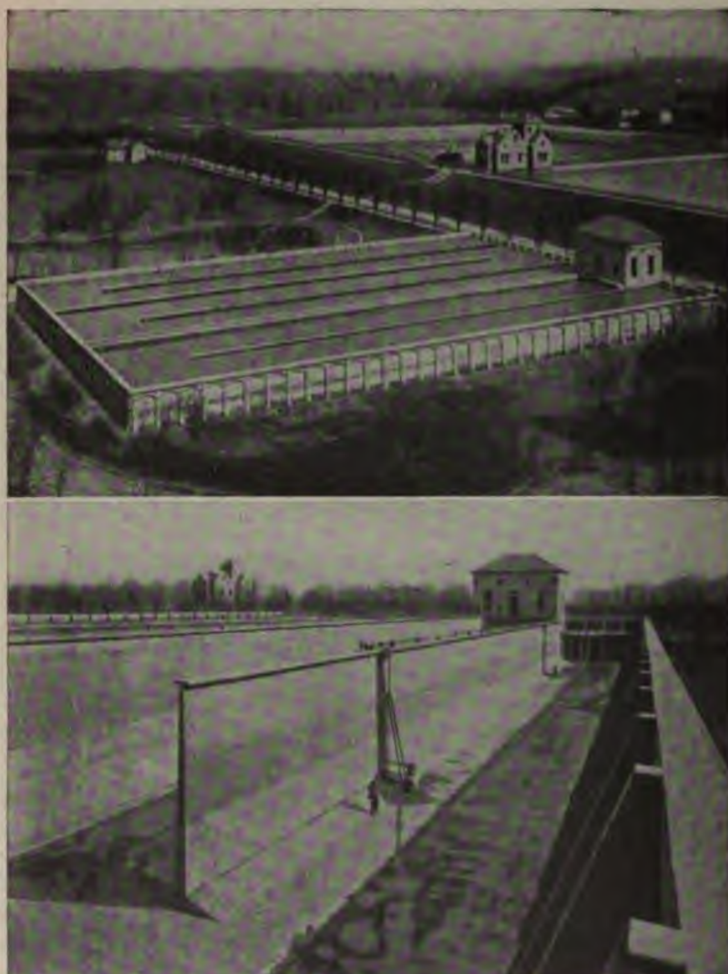

FIG. 32.—Sedimentation and coagulation basins at Louisville. Note the long vertical partitions or baffles which reduce the velocity of the water in passing through the basins. (*Water-supply Paper* 315, *U. S. Geological Survey*.)

soluble, is thrown out of solution as a coarse, flocculent precipitate in which most of the suspended matter and bacteria become enmeshed (Fig. 32).

In practice only sufficient alum is added to combine with the carbonates, so that no alum remains in solution and all of the precipitate is removed (Fig. 40). Iron sulphate is similarly used. If sufficient carbonates to break up the alum are not present normally, the required alkalinity is secured by the addition of lime or soda to the water.

5. Slow Sand Filtration.—This is accomplished by large filters, either open or covered, each about an acre in extent (Fig. 33) consisting of collecting tiles overlain with gravel and

FIG. 33.—Bird's eye view of the covered slow sand filters at Providence showing the pumping station, laboratory, filter roofs and the storage of dirty sand. (1910 *Rep. Providence City Engineer.*)

coarse sand (Fig. 34). These are operated with ahead of from two to four feet of water above the sand (Fig. 35). Bacterial removal is not accomplished by any straining action of the sand grains, but by the development of algæ and protozoa in the surface layers of the sand, which reduce the interstices still further and prey upon bacteria. When this biological film is sufficiently developed the water passing a filter is used. Under these conditions it is so operated as to permit the passage of from 2.5 to 5 million gallons of water per acre per day. The biological film continues to develop during the course of several

weeks to such an extent that the passage of water gradually becomes seriously hindered, whereupon the filter is drained, and the top layer of sand is removed (Fig. 36). After cleaning, the filter is again placed in commission and the process of cleaning is repeated as often as necessary. When the sand layer is reduced to 12 to 18 inches in depth, the filter is drained and the sand, which in the meantime has been washed, is restored to the filter (Fig. 37).

Preliminary methods of treatment are not required, although the process is not adapted to turbid water. The first cost of

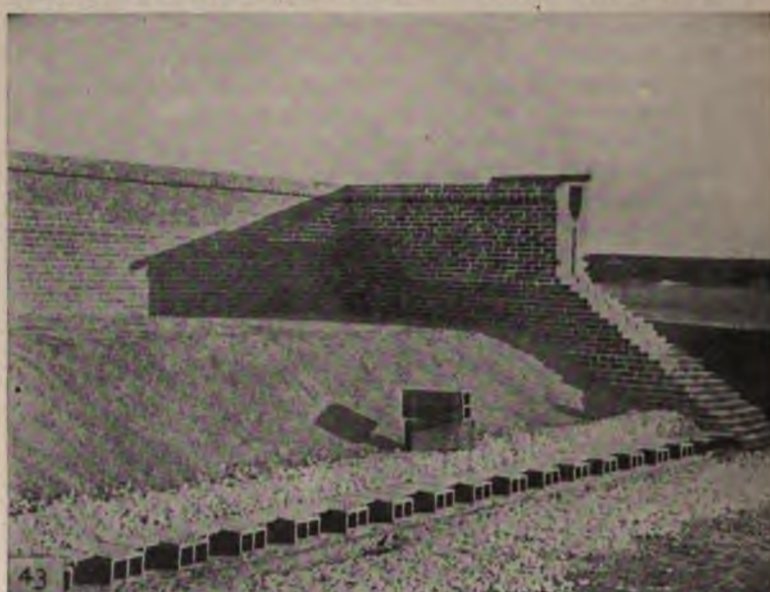

FIG. 34.—Cross-section of a typical slow sand filter. Note the under drains, which are of an uncommon type, the layer of superimposed gravel, and the thick layer of coarse sand. (*Mason, "Water Supply," John Wiley and Sons.*)

installing such a filter plant is large, but the operating cost is low. The filter accomplishes a bacterial removal of about 99 per cent. and is extremely uniform in its action.

6. Rapid Sand Filtration.—This is accomplished by two types of filters, either pressure or gravity, according to the manner in which the head of water is secured upon the filter. The operation of each is based upon the same principle. This method requires only a small installation with a low initial cost, but a high cost of maintenance. They are very efficient

in the removal of color and turbidity, and slightly less efficient (95 per cent. to 99 per cent.) and less uniform in the degree of bacterial removal secured as compared with slow sand filters. Filtration is effected by the formation of a thin film of the precipitated coagulant upon the surface of the sand through which the water passes, either by gravity or pressure. Since the film of precipitate held back by the sand is constantly increasing, the amount of water which passes through is soon finally reduced below efficient limits. When this occurs, usually every 6 to 12 hours, the filter is disconnected and the precipi-

FIG. 35.—Filter bed No. 6, Indianapolis Water Company. This illustration shows the smooth, clean surface of the sand in a filter bed which is ready for water to be admitted. The water covers the sand to a depth of about four feet.

tate removed by reversing the flow of water, and agitating the sand, either by means of compressed air or mechanical rakes (Figs. 39, 42). The dirty wash water is wasted. When the sand is cleaned, the reverse flow is stopped, the sand settles into place over the gravel, and the coagulant containing water is again sent through the filter. These filters are operated at the rate of 100 to 150 million gallons per acre per day, hence the small installations.

Sedimentation to remove some of the precipitated coagulant

is usually used as a preliminary process, in order to prevent the too rapid clogging of the filters.

The gravity filters are open vats or reservoirs or wood or concrete (Fig. 41), while the pressure filters are cylindrical steel tanks (Figs. 38, 39).

7. Disinfection of Water.—In this country chlorine is the only agent extensively employed for this purpose, and is applied either as liquid chlorine or a solution of bleaching powder. Disinfection is applied as a finishing process to water that has

FIG. 36.—Filter bed No. 1, Indianapolis Water Company. This shows workmen cleaning or scraping a filter bed to remove the muddy upper layer of sand containing the impurities from the water. The sand is thrown into piles previous to being removed for washing.

been previously filtered or otherwise clarified. The value of the process from the standpoint of the destruction of the bacteria which pass through the filters, including pathogenic and non-pathogenic germs, has been well demonstrated. From .1 to .5 parts per million of available chlorine are commonly employed, requiring the addition of about 5 to 12 pounds of bleach per million gallons of water. Quantities of bleach in excess of 25 pounds can be detected by taste. Of recent years the employment of liquid chlorine has been superseding bleach, owing to the lesser cost of the former, as well as its convenience (Fig. 43). The

FIG. 37.—Sand washing machine, Indianapolis Water Company. Sand being removed from filter bed, washed and stored by hydraulic machinery.

FIG. 38.—Mechanical filters at Chattanooga, Tenn. Note the vertical shafts at the top of each pressure filter unit. To these shafts are connected the revolving rakes which agitate the sand when the filter is washed. The shafting revolves the rakes. It is because of these connections that pressure filters are sometimes called mechanical filters. (*Courtesy of American Water Works and Guarantee Company.*)

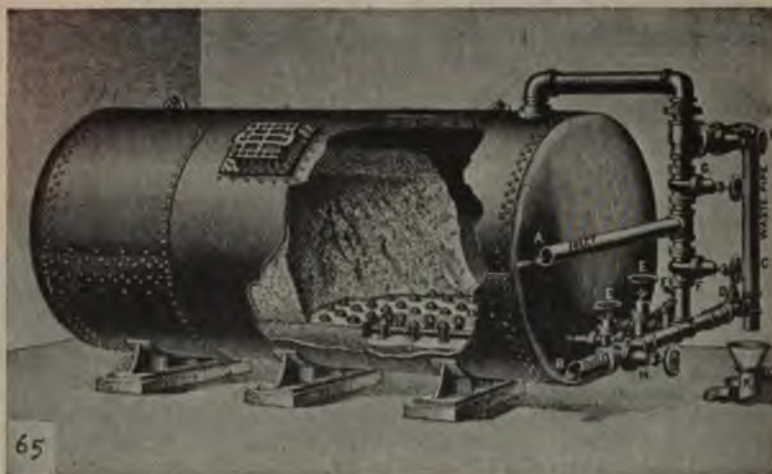

FIG. 39.—Schematic view of a typical rapid sand filter of the pressure type. (*Mason, "Water Supply," John Wiley and Sons.*)

FIG. 40.—Coagulant storage and feeding devices at Scranton. The coagulant solutions are stored in the tanks on the platform, and fed into the raw water by means of the constant head device on the floor below. (*Water Supply Paper 315. U. S. Geological Survey.*)

amount required is greater when the content of the water in organic matter is high. Disinfection is probably accomplished

FIG. 41.—Interior of the gravity type filter house at Little Falls. The filter units are observed beyond the railing at either side. The operation of each filter unit is controlled by means of electrically operated valves, manipulated from the table in front of each filter. (*Courtesy of Mr. G. W. Fuller.*)

FIG. 42.—A gravity filter unit at Watertown, N. Y., with the sand and gravel removed. Note the strainers and piping for collecting the filtered water, the pipes for the compressed air used to agitate the sand in washing, and the wooden troughs at the top, which carry the waste wash water away. (*Hazen: "Clean Water and How to Get It," John Wiley and Sons.*)

by nascent oxygen liberated by the hypochlorous acid formed by the mixture of the bleach with the water.

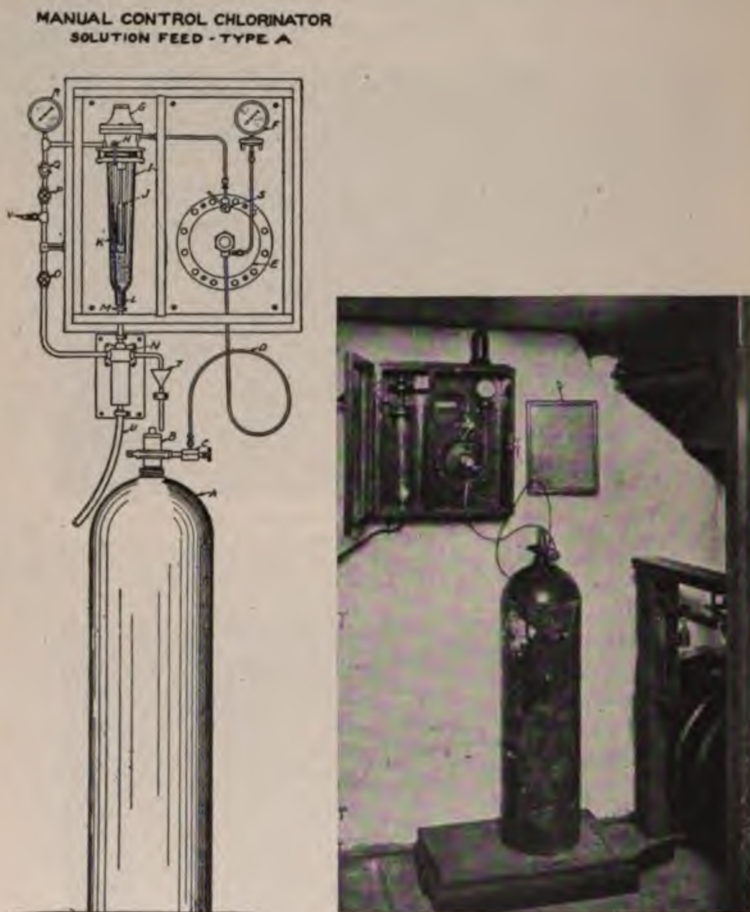

Fig. 43.—Photograph and diagram of a typical device for the disinfection of water by liquid chlorine. (*Wallace and Tiernan Co., New York.*)

I, Chlorine absorption chamber; *K–L*, chlorine solution line; *V*, water connection; *P*, water valve; *R*, gauge; *O*, water valve to water seal *N*; *T*, water spill; *U*, chlorine solution line to point of application; *N*, water seal; *Size*, apparatus mounted in wall cabinet 20 × 21 inches; *S*, control valve; *A*, chlorine tank; *B*, valve on chlorine tank; *C*, auxiliary valve; *D*, flexible connection; *E*, pressure compensating valve for taking care of the varying pressures in the chlorine tank and also maintaining a constant drop in pressure across the valve *S*; *S*, control valve; *G*, valve to prevent moisture from getting back into control parts of apparatus; *H*, valve to control flow of water and to keep chlorine out of incoming water connections; *F*, pressure gauge showing pressure in tank; *J*, chlorine flow meter (inverted siphon type).

8. Results of Water Purification and Disinfection.—Since the first serious attempt at water purification in the United States in 1872, the practice has abundantly justified itself as a sanitary measure of the highest order. Endemic water borne typhoid has either been eliminated or greatly reduced in the municipalities making the change. In Table V are presented a few examples to show the typical results which have been secured.

TABLE V

EFFECT OF WATER PURIFICATION ON TYPHOID RATES. AVERAGE TYPHOID DEATH RATE PER 100,000 POPULATION (After ROSENAU).

City	Average before improvement	Average after improvement	Percentage reduction
Albany	88.8	23.7	73.0
Elmira	54.9	41.5	24.4
Hudson	64.3	31.9	50.5
Ithaca	67.2	14.6	78.3
Schenectady	25.0	14.4	42.6
Troy	58.2	31.0	46.8
Watertown	94.7	36.9	61.8
Binghampton	39.3	11.7	72.3
Rensselær	95.5	54.4	43.0

TABLE VI

EFFECT OF CHLORINATION ON TYPHOID RATES. AVERAGE TYPHOID DEATH RATE PER 100,000 POPULATION (AFTER RACE)

City	Chlorination begun	Before using		After using		Percentage reduction
		Period	Rate	Period	Rate	
Baltimore	June, 1911	1900–10	35.2	1912–15	22.2	36
Cleveland	Sept., 1911	1900–10	35.5	1912–16	8.2	77
Des Moinss	Dec., 1910	1905–10	22.7	1911–13	13.4	41
Erie	March, 1911	1906–10	50.6	1912–14	15.0	70
Evanston, Ill.	Dec., 1911	1908–11	29.0	1912–13	14.5	50
Jersey City	Sept., 1908	1900–17	18.7	1909–16	8.4	55
Kansas City, Mo.	Jan., 1911	1900–10	42.5	1911–16	14.2	66
Omaha, Neb.	May, 1910	1900–09	22.5	1911–16	10.6	53
Trenton	Dec., 1911	1907–11	46.0	1911–14	28.7	35
Montreal	Feb., 1910	1906–10	40.0	1911–16	25.0	37
Toronto	April, 1911	1906–10	31.2	1912–16	7.8	75
Ottawa	Sept., 1912	1906–10	34.0	1913–17	17.0	50

Though a much more recent development, the reduction in typhoid rates effected by chlorination of water are every bit as striking as those secured by purification. The experience of a few cities is summarized in Table VI.

TABLE VII

TYPHOID FEVER IN BURLINGTON, VERMONT

Year	Death rates per 100,000 from typhoid fever,
1904	36
1905	34
1906	43
1907	23
1908	20 (Mechanical filter plant opened in April).
1909	25
1910	11 (Bleach applied to water in April).
1911	7
1912	4

Evidence is accumulating to indicate that purification in itself did not succeed in completely eliminating water borne typhoid. Cities which experienced a reduction in their typhoid rates following the installation of a purification plant experienced a still further reduction after the inauguration of disinfection. An example of this experience is shown in Table VII.

In addition, several instances have been observed of typhoid and dysentery outbreaks following emergencies when purification plants were temporarily shut down because of floods or accidents.

In addition to affecting a reduction in the typhoid death rate, Mills and Reincke noted (Mills-Reincke phenomenon) that following the improvement in a water supply by the introduction of purification processes, there is not only a drop in the typhoid death rate, but a drop in the general death rate as well. From studies by McLaughlin it would appear this decline is due to a decrease in infantile deaths from diarrhea.

The type of purification process or processes best adapted to a given source of water supply, as well as the source of a contemplated municipal supply itself, had best be selected by competent sanitary engineers after careful study has been made of the source, its probable ability to supply the demands of a growing population for the next twenty or thirty years and the character of the impurities whose removal is necessary.

9. Domestic Water Supplies (Figs. 44, 45, 46, 47).—These include wells, springs, and cisterns. It is important to remember that with these the danger of contamination is practically exclusively from surfaces sources. They should therefore be protected from surface drainage, and have tight water-proof tops. They should also be located a considerable distance

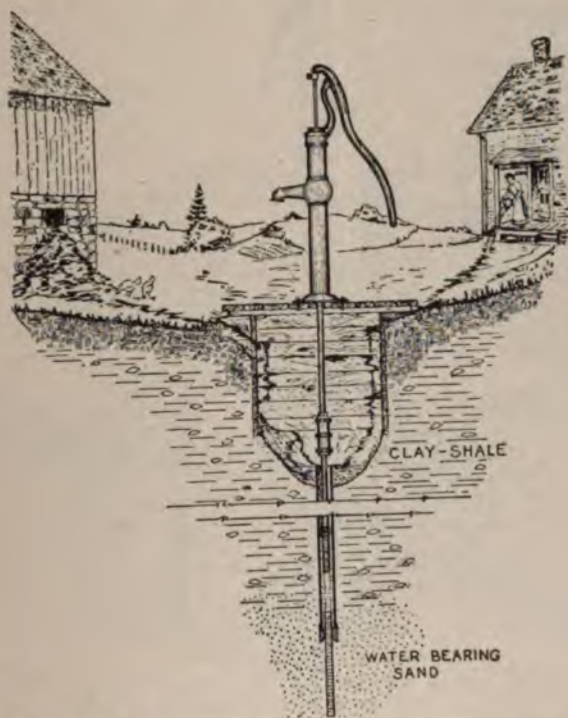

Fig. 44.—Showing how pollution may enter an improperly located and poorly constructed well. Most contamination of wells enters from the top. Note the drainage toward the well. (*Minn. State Board of Health.*)

from sewers, privies and cess pools. Underground contamination may occur in clayey or gravely soils or in limestone regions, owing to the fissured or open character of the sub-soil. Shallow wells are frequently contaminated.

10. Emergency Protection in the Home.—The various domestic filters are of little value, as in order to give satisfactory results they must be cleaned frequently, at least daily, and it

is rare for them to receive this care. They are apt to give a false sense of security.

Boiling drinking water from 15 to 20 minutes is one of the best emergency safeguards that can be employed. Another method of equal value is the employment of bleach or chlori-

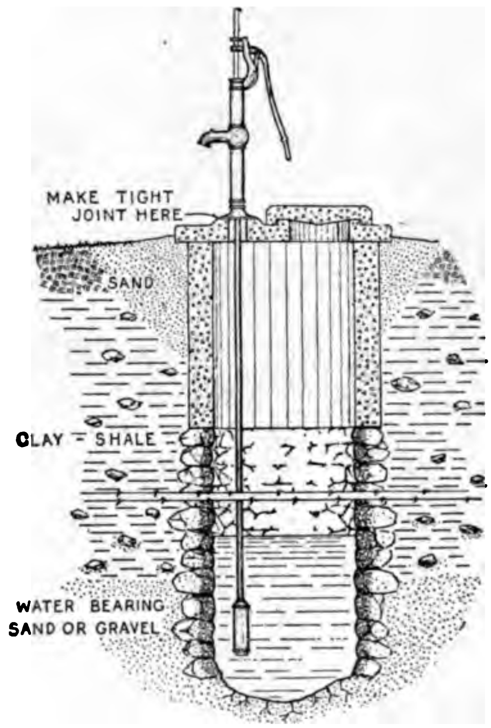

FIG. 45.—Showing how a well can be protected against pollution. (*Minn. State Board of Health.*)

nated lime. A stock solution of bleach is made by adding one teaspoonful of fresh chlorinated lime to a pint of water. This is added to the drinking water in the proportion of one teaspoonful to ten gallons, or nine drops to one quart, and allowed to act for 15 to 30 minutes before the water is consumed.

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STEIN: Water Purification Plants and Their Operation.

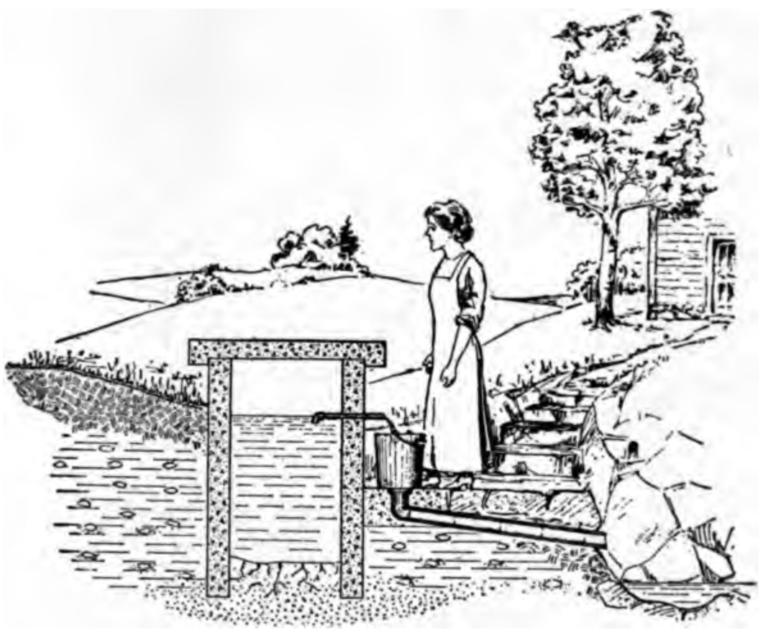

FIG. 46.—Showing how a spring can be protected against pollution. (*Minn. State Board of Health.*)

JOHNSON: The Purification of Public Water Supplies. Water Supply Paper No. 315, U. S. Geological Survey.
FREEMAN: Good Water for Farm Homes. Public Health Bulletin No. 70 U. S. Public Health Service.
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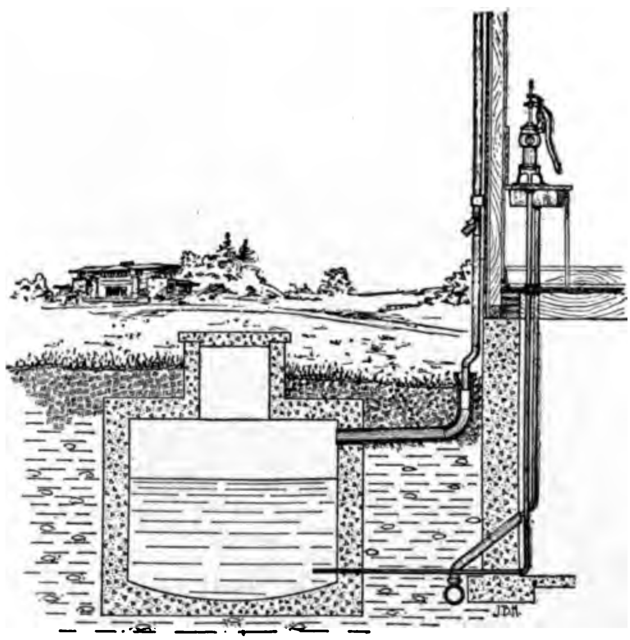

FIG. 47.—Showing a properly constructed cistern located outside the house. (*Minn. State Board of Health.*)

The Chemical Disinfection of Water. Reprint 225, Public Health Reports.
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CHAPTER XVII

PRODUCTION AND INSPECTION OF MILK

1. Of all substances consumed as food the position of milk is unique. And of course in the northern temperate latitudes when we speak of milk one naturally understands that cows milk is understood. It owes its unique position to the following circumstances as pointed out by Rosenau:

(1) It is the only standard article of diet obtained from animal sources that is ordinarily consumed in its raw state; *i.e.*, it is not ordinarily heated in some cooking process prior to consumption.

(2) Its peculiar composition renders it highly suitable as a medium for a wide variety of micro-organisms, both pathogenic and non-pathogenic.

(3) The foregoing characteristics subject milk to rapid changes as a result of the activity of the micro-organisms, some of which may produce decompositions that render the milk unfit or even dangerous as food. As a consequence of these decompositions the original character of the milk may be largely lost or markedly altered.

(4) The conditions of the production and the activity of micro-organisms make milk the most difficult of all animal foods to obtain, to handle, to transport and to deliver in a clean, fresh and satisfactory manner.

These peculiarities serve to indicate the important relationship which milk possesses to both health and disease. Thus: (1) As a result of the favorable environment it creates for micro-organisms, it may serve as an important route for the dissemination of several species of infective agents; (2) Devised as it is by nature as the first food for the calf, it serves nearly equally as well as food for the young of the human species as well as for human adults, due to the proportion in which the different food elements are present. But on the other hand, when its composition is altered by microbial activity arising from improper care, it may become a dangerous instead of a safe food; (3) In addition to possessing all the different food elements in its composition, the elements are present in proper relative proportions, so that milk may be said to be the only

properly balanced food. Furthermore all the different substances present are readily digestible. If one tends to tire of a milk diet, the monotony may be relieved by some of the numerous modifications which the cook or housewife may devise.

2. **Sophistication of Milk.**—Unscrupulous dairymen the world over make a more or less frequent practice of altering the milk they retail, either by abstracting the more valuable constituents, such as the butter fat, or by adding diluents or endeavoring to conceal changes of decomposition, or to prevent decomposition by improper methods. Under these headings come the practices of skimming, watering, adding of skimmed milk, thickening, coloring and the addition of alkalies or of chemical preservatives.

These practices are unjustifiable and fraudulent, but since the health of the consumer is as a general rule unaffected, though his pocket book is depleted by fraud, we must regard this question as of economic importance rather than of sanitary importance. The only situation where the health of individuals might suffer as a consequence is in situations where milk of a certain composition is desired, as for example, for the feeding of tuberculous patients or of infants, with whom it would constitute the principal article of the diet.

3. **Source of Micro-organisms in Milk.**—The hygienic importance of milk is closely related to its microbial content, not that the myriads of micro-organisms which thrive in milk are in themselves necessarily harmful, but rather the extent of their abundance gives important information relative to the age of the milk, the degree of care exercised in its production and handling, and the conditions under which it has been stored. It must be borne in mind that an exact or even a fairly close approximate determination of the number of bacteria per unit volume of milk cannot be secured, and that the best results are only in reality approximations. Furthermore the enumerations secured vary with the technic employed. An exposition of these phases of bacteriologic procedure would be too extensive for presentation here, so reference must be made to other sources of information.

Since the questions of production, handling, storage and age, closely affect the microbial content of milk, it is necessary to consider their influences.

(1) *Production and Handling.*—The amount of fresh milk consumed daily in this country is enormous. Practically all

the milk of this supply is furnished by small producers, the majority of whom at present have no special knowledge of the conditions necessary for the production of a hygienic milk, or the facilities to apply such knowledge. The milk supply of the large centers of population is secured from the small producers within a radius of from 100 to 200 miles and, owing to transportation difficulties, may be thirty six hours old when it reaches the consumer. On the other hand with the smaller cities and towns the radius of production is narrower and the consumer seldom gets milk 24 hours of age and usually less.

FIG. 48.—Dirty flanks. A common condition in winter. Flanks become caked with manure, which there is often no thought of removing. This is the source of the dirt found in milk in winter time. (*Webster, Bull. No. 56, Hygienic Laboratory.*)

The principal sources from which micro-organisms gain introduction are the following:

1. The udder and teats of the cow, as well as their flanks and bellies (Fig. 48).
2. The hands of the milker.
3. Dirt and dust of the stables (Figs. 50, 51).
4. Cow manure (Fig. 48).
5. Milking utensils.

Of these the first, fourth and fifth are probably of greatest

importance. In general it may be said that the presence of micro-organisms is closely associated with the introduction of dirt, particularly cow manure, which commonly gains introduction from the teats, udder and flanks of the cow by dropping into the milking pail (Fig. 49). It is therefore apparent that a milking pail with a small top will prove of material assistance in reducing the amount of dirt that gains entrance (Fig. 59). In addition the thorough brushing of the cows with brush and curry comb (Fig. 52) followed by a wiping with a damp cloth,

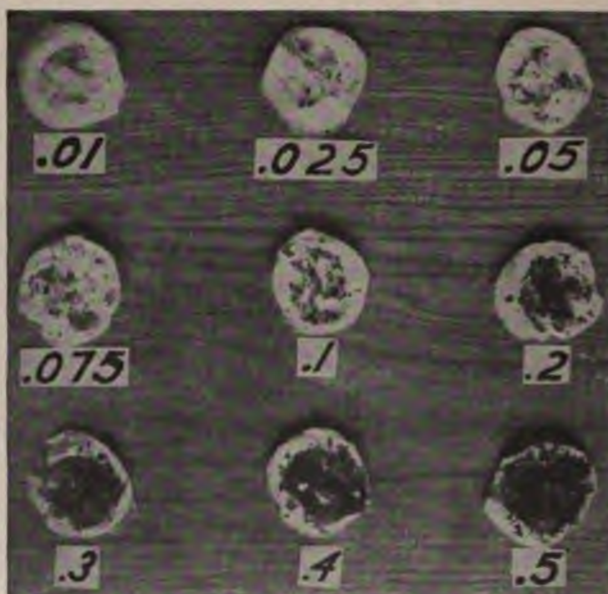

FIG. 49.—Sediment disks showing from 0.01 to 0.5 gram of fresh manure removed from different bottles of milk. (*Bull.* 642, *U. S. Dept. of Agriculture.*)

largely eliminates gross dirt from the milk pail. The character of the milk pails and utensils is of importance from another standpoint. If their interior is rusty or their seams rough, their cleaning is made difficult. Milk remains in the recesses in which bacteria multiply and which serve as cultures to seed the fresh milk when the utensils are again in use Hence in addition to possessing small tops, the milk pail should have a smooth interior and be subjected to sterilization after cleansing. For this purpose streaming steam is very effective. (Fig 57).

The temperature at which the milk is tored between the interval of its production and its consumption is of great importance. If kept at air temperature, bacterial multiplication will be rapid and the milk will soon spoil. The rapid cooling (Fig. 55) of the milk after its drawing and its maintenance at a temperature of 10°C. (50°F.) or lower will largely inhibit bacterial multiplication and hence prevent decomposition. Practically sterile milk in commercial quantities cannot be produced, but on the other hand, care in the production and handling of milk will keep the count very low.

Fig. 50.—Stable yards of this type are all too common. The cows are compelled to wade knee deep in manure in order to get into the stable Much of the filth on legs and tail from this source gets into the milk. (*Bull.* 56. *Hygienic Laboratory.*)

4. Classification of Milk.—From a hygienic standpoint we may consider either of two classifications of milk, first:

(*a*) Raw milk, and

(*b*) Pasteurized milk.

Raw milk includes all milk that has not been heated to a temperature sufficient to destroy most bacteria, and which at the same time will not alter the nutritional properties of the milk. Hygienically, raw milk may be of any grade of the second classification. Potentially it is dangerous, since with

the greatest of care it is impossible to prevent the introduction of infective agents into some lots.

Pasteurization is a process of sterilizing or partially sterilizing organic solutions without altering their chemical properties, devised by Pasteur and first applied to beer and wines (Fig. 58). As applied to milk or cream three methods are in use. They are the following:

(*a*) The flash method which from a hygienic standpoint is the poorest. It is used chiefly in those dairies run as adjuncts

FIG. 51.—A dirty stable interior. (*Bull. 56. Hygienic Laboratory.*)

to creameries, where the milk or cream is heated to destroy undesirable lactic fermentation. These lactic organisms are destroyed at temperatures lower than the pathogenic organisms likely to be present, hence the latter are not affected. The milk is momentarily heated but the temperature is not maintained.

(*b*) The holding process: The milk is heated in large vats and the temperature maintained for some time (Fig. 59). The temperature used is sufficient to kill pathogenic organisms. At the completion of the process the hot milk is cooled by running

over cooling coils and then bottled (Fig. 56). The process will efficiently destroy infective agents present, but the milk may be subsequently contaminated.

(*c*) The in-bottle method, which is a modification of the holding process. The milk is run into clean bottles, the bottles capped with crown seals and submerged in vats of water which are heated to the desired temperature and this temperature maintained, or they are placed in closed chambers and sprayed with hot water. Various commercial modifications of the pro-

FIG. 52.—Cleaning cows preparatory to milking. A simple operation requiring no other outlay than a little time. (*Bull.* 56, *Hygienic Laboratory*).

cedure are in vogue (Figs. 60, 61). After heating the bottles are cooled and chilled. This method possesses the advantage that subsequent contamination is prevented.

The most satisfactory pasteurization from a hygienic standpoint is achieved by holding the milk from 35 to 40 minutes at a temperature of 65 degrees C. (Fig. 58). Pasteurization does not alter the digestibility of the milk; though some may observe a difference in its palatability. The heating alters the viscosity of the butter-fat, so that a distinct cream line is not

formed. Oxidases and vitamines are destroyed, so that pasteurized milk used for infant feeding should be supplemented

FIG. 53.—A clean light, airy interior. Milkers at work are dressed in clean white suits and caps. Cows are clean. An ideal place. (*Bull. 56, Hygienic Laboratory*).

FIG. 54.—Types of milk pails. Narrow-top pails are best. (*Bull. 56. Hygienic Laboratory*).

with orange juice to supply vitamines, otherwise some children may develop infantile scurvy. Pasteurized milk must be

cooled and carefully kept cool, otherwise it is apt to putrify instead of souring, due to the destruction of the lactic ferments, while the spore forming proteolytic bacteria survive the heating. To secure the maximum protection, all pasteurizing vats should be equipped with recording thermometers, and the process should be carried out under official supervision.

2. By another classification milk may be divided into three grades:

(*a*) Certified milk.

FIG. 54*a*.—A good type of inexpensive milk house. A milk house, separate from the dwelling and stable, is indispensable. Here the milk should be brought for cooling and bottling, and here the milk utensils should be cleaned and sterilized. (*Bull. 56, Hygienic Laboratory.*)

(*b*) Inspected milk.

(*c*) Market milk.

The use of the term certified, as applied to milk, is limited to milk produced in accordance with the requirements of the American Association of Medical Milk Commissions. For its production, the dairyman enters into a contract with the association, agreeing to the following conditions, in return for which his milk is certified.

(*a*) The producing dairies shall be periodically inspected.

(*b*) Frequent analysis of the milk shall be made.

(*c*) Pure water shall be supplied for dairy use.

(*d*) The dairy herd shall be free from tuberculosis as demonstrated by frequent inspections and tuberculin tests. In addition all cows shall be free from other diseases liable to cause deterioration of milk.

(*e*) The stables must be kept clean and be properly ventilated and lighted.

(*f*) The cows must be properly fed and cared for.

FIG. 55.—A very neat, inexpensive, small, bottling room. Note at the right the conical cooler, over which the warm milk is allowed to flow. (*Bull. 56, Hygienic Laboratory.*)

(*g*) All milk handlers must be free from communicable diseases. They must observe scrupulous cleanliness in their work (Fig. 53).

(*h*) All care must be used in milking, the milk must be promptly cooled, placed in sterile bottles and stored at 50 degrees F. or lower until delivered (Fig. 59).

(*i*) A bacterial count not in excess of 10,000 per c.c. is permitted and the milk must not be over 24 hours old when delivered.

Certified milk represents the highest grade of milk obtainable. Its careful production makes it well adapted to infant feeding.

FIG. 56.—Bottling room in a high-class city dairy. Milk is cooled by flowing over the corrugated cooler in the center of the illustration, after which it flows into the tank of the bottling machine below. (*Bull. 56, Hygienic Laboratory.*)

FIG. 57.—Loew hydro-pressure bottle washer. Installed in Meyer Sanitary Milk Co., Kansas City, Kansas. A machine for the washing and wrinsing of milk bottles. (*Loew Mfg. Co., Cleveland, O.*)

The term inspected milk is applied to a very good grade of raw milk, however not as reliable as the certified grade. It is applied to clean, fresh milk from healthy cows which are tuberculin tested and examined by a veterinarian. The cows are fed, watered, housed and milked under good conditions, but not necessarily equal to those required for certified milk.

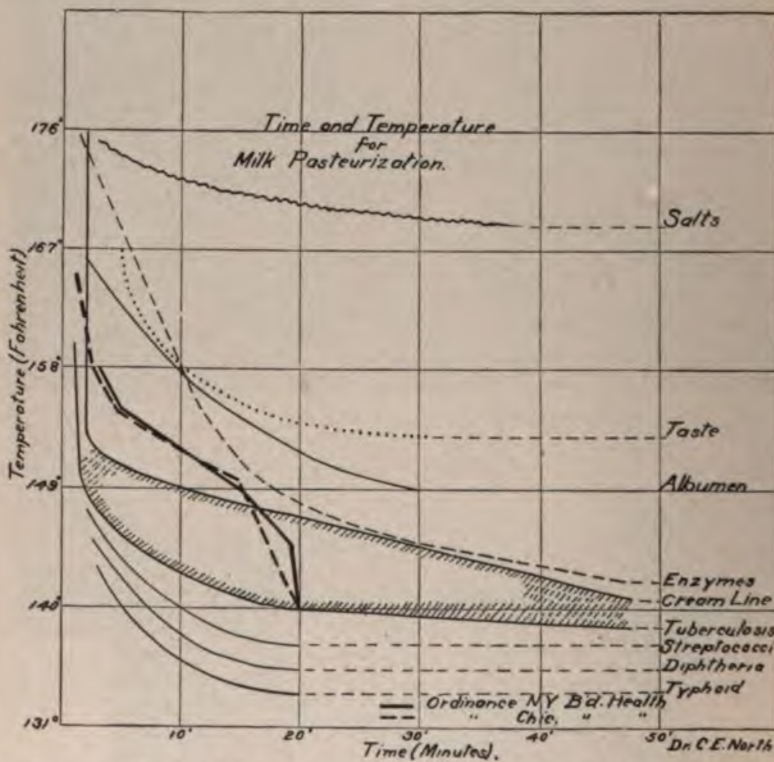

FIG. 58.—Showing the time and temperature necessary for the destruction of infective agents in milk, with the effect of heat on the constituents of milk. (*Dr. C. E. North, N. Y. City.*)

Scrupulous cleanliness must be used in milking and care taken to prevent persons having communicable disease coming in contact with the milk. It should be placed in sterile bottles and stored at 50 degrees F. A bacterial count of not over 100,000 bacteria per c.c. is permissible.

The term market milk is applied to all milk not certified or inspected in accordance with the above definitions, and to all

milk of unknown origin. Common sense indicates the necessity for the pasteurization of all milk of this grade.

5. Dairy Inspection.—Improvement in the hygienic quality of milk can best be accomplished by supervision of the conditions under which milk is produced and handled. Results are accomplished along two lines (1) by the enforcement of regulations designed to secure proper conditions and methods, and

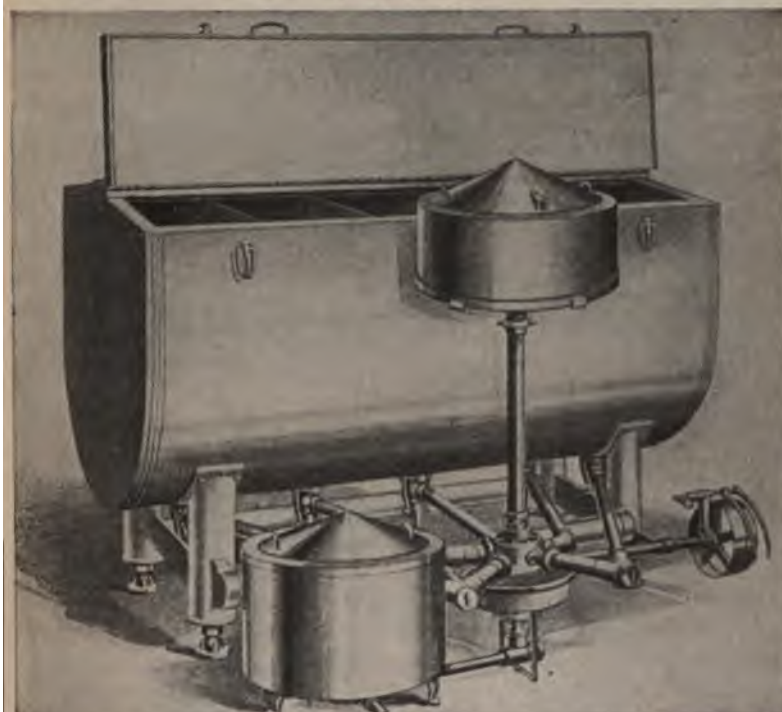

FIG. 59.—A vat pasteurizer suitable for the pasteurization of milk by the holding process. (*Miller Pasteurizing Machine Co., Canton, O.*)

(2) the education of dairymen along the lines of hygienic milk production. There can be no doubt that markedly beneficial results follow the introduction of efficient systems of inspection by tactful inspectors. On the other hand, inspection will not cure all of the evils or absolutely safeguard the milk supply. Inspection requires that all sources of supply be examined, hence in order that they may be known to the authorities a system of liscensure is necessary. Inspections are

of the greatest value when a fixed routine is followed in making the inspections. To this end score cards are of great value.

FIG. 60.—A large type of pasteurizing machine, for in-bottle pasteurizing. Capacity 5000 pint bottles per hour. (*Barry-Wehmiller Machinery Co., St. Louis, Mo.*)

FIG. 61.—Loew in-the-bottle pasteurizer. Installed by Meyer Sanitary Milk Co., Kansas City, Kansas. Another type of in-bottle pasteurizer. The milk is heated by jets of hot-water. (*Loew Mfg. Co., Cleveland, O.*)

Score cards are constructed on a percentage basis, different values being assigned to different phases of the subject; equip-

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
DAIRY DIVISION.

SANITARY INSPECTION OF DAIRY FARMS.

SCORE CARD.

Indorsed by the Official Dairy Instructors' Association.

Owner or lessee of farm ....

P. O. address .... State ....

Total number of cows .... Number milking ....

Gallons of milk produced daily ....

Product is sold by producer in families, hotels, restaurants, stores,

to .... dealer.

For milk supply of ....

Permit No. .... Date of inspection ...., 191

REMARKS: ....

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(*Signed*) ....

Inspector.

D. D. 316.—6-8-15—5,000. 8—1763

FIG. 62.

EQUIPMENT	SCORE. Perfect.	SCORE. Allowed.
COWS.		
Health	6	
Apparently in good health ... 1		
If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed ... 5		
(If tested within a year and reacting animals are found and removed, 3.)		
Food (clean and wholesome)	1	
Water (clean and fresh)	1	
STABLES.		
Location of stable	2	
Well drained ... 1		
Free from contaminating surroundings ... 1		
Construction of stable	4	
Tight, sound floor and proper gutter ... 2		
Smooth, tight walls and ceiling ... 1		
Proper stall, tie, and manger ... 1		
Provision for light: Four sq. ft. of glass per cow	4	
(Three sq. ft., 3, 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)		
Bedding	1	
Ventilation	7	
Provision for fresh air, controllable flue system ... 3		
(Windows hinged at bottom, 1.5; sliding windows, 1; other openings, 0.5.)		
Cubic feet of space per cow, 500 ft ... 3		
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., 0.)		
Provision for controlling temperature ... 1		
UTENSILS.		
Construction and condition of utensils	1	
Water for cleaning	1	
(Clean, convenient, and abundant.)		
Small-top milking pail	5	
Milk cooler	1	
Clean milking suits	1	
MILK ROOM OR MILK HOUSE.		
Location: Free from contaminating surroundings	1	
Construction of milk room	2	
Floor, walls, and ceiling ... 1		
Light, ventilation, screens ... 1		
Separate rooms for washing utensils and handling milk	1	
Facilities for steam	1	
(Hot water, 0.5.)		
Total	40	

METHODS.	SCORE Perfect.	SCORE Allowed.
COWS.		
Clean	8	
(Free from visible dirt, 6.)		
STABLES.		
Cleanliness of stables	6	
Floor ... 2		
Walls ... 1		
Ceiling and ledges ... 1		
Mangers and partitions ... 1		
Windows ... 1		
Stable air at milking time	5	
Freedom from dust ... 3		
Freedom from odors ... 2		
Cleanliness of bedding	1	
Barnyard	2	
Clean ... 1		
Well drained ... 1		
Removal of manure daily to 50 feet from stable	2	
MILK ROOM OR MILK HOUSE.		
Cleanliness of milk room	3	
UTENSILS AND MILKING.		
Care and cleanliness of utensils	8	
Thoroughly washed ... 2		
Sterilized in steam for 15 minutes ... 3		
(Placed over steam jet, or scalded with boiling water, 2.)		
Protected from contamination ... 3		
Cleanliness of milking	9	
Clean, dry hands ... 3		
Udders washed and wiped ... 6		
(Udders cleaned with moist cloth, 4; cleaned with dry cloth or brush at least 15 minutes before milking, 1.)		
HANDLING THE MILK.		
Cleanliness of attendants in milk room	2	
Milk removed immediately from stable without pouring from pail	2	
Cooled immediately after milking each cow	2	
Cooled below 50° F.	5	
(51° to 55°, 4; 56° to 60°, 2.)		
Stored below 50° F.	3	
(51° to 55°, 2; 56° to 60°, 1.)		
Transportation below 50° F.	2	
(51° to 55°, 1.5; 56° to 60°, 1.)		
(If delivered twice a day, allow perfect score for storage and transportation.)		
Total	60	

Equipment .... + Methods .... = ... Final Score.

NOTE 1.—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

NOTE 2.—If the water is exposed to dangerous contamination, or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0. 8—1763

FIG. 62.—(*Continued.*)

ment and methods (Fig. 62). If perfect, a 100 score would be allowed, but suitable deductions are made for the observed deficiencies. The method permits of the fairest comparison of different dairies and permits the dairyman to understand the deficiencies of his equipment and methods. Where the score cards are devised upon a proper basis, *i.e.*, emphasize the important factors in the production of a safe milk and ignore or minimize the trivial features, excellent results will follow. It is physically impossible, however, to secure a sufficient staff of inspectors to insure the freedom of a milk supply from infection at all times. Inspection is of value in the investigation of supposed milk born outbreaks and doubtless prevents many, but it is not an absolute safeguard.

6. The Care of Milk in the Home.—Proper care of milk in the home is of fundamental importance when employed in infant feeding, though less so in the case of adults. Its importance will be brought out later. For the present we will only consider what constitutes proper care. In the main this consists in maintaining proper conditions of storage, so that the milk is kept chilled until it is entirely consumed. In the homes of the well-to-do, where refrigerators and a constant supply of ice are available, this is no problem. On the other hand in the homes of the poor where refrigerators are not available, a little ingenuity, together with a regular supply of ice will meet all requirements. A very simple home made milk refrigerator is described in Public Health Bulletin No. 102 of the Public Health Service.

It may also be advisable or necessary to pasteurize milk in the home, either as a routine or as an emergency procedure. Of course doubtful milk can be rendered safe by boiling, though few people find the taste of boiled milk palatable. Home pasteurization should be practised where cows milk is required for infant feeding and where the only milk available is of the inspected or market grades. Since the principles of pasteurization have already been explained it is not necessary to describe their adaption to this purpose, since ingenuity can readily adapt the process to local home facilities. (See circ. 197 Bureau Animal Industry, U. S. Dept of Agriculture).

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CHAPTER XVIII

MILK AS A ROUTE OF INFECTION

1. Milk as a Medium for Bacteria.—In this connection it is necessary to call attention to a phenomenon observed in milk which is commonly referred to as the "germicidal" property. In the first few hours after milk is withdrawn from the cow there is a transitory reduction in the number of colonies which develope on plates poured from unit volumes of milk, as compared with the number originally present. In a few hours the numbers show no further reduction, commence to increase and soon greatly exceed those originally present. This phenomenon is not apparent in milk which has been heated to 50 degrees C. Several explanations have been advanced.

(*a*) Some consider this phenomenon as a manifestation of a true germicidal property in milk and that the temporary diminution is due to a partial destruction of the bacteria originally introduced.

(*b*) Or it may be due to an inhibition of those species which find milk an unfavorable environment for development.

(*c*) Others consider the phenomenon is due to the action of agglutination, *i.e.*, the reduction in colonies is due to the clumping of bacteria and that their numbers are not actually reduced. This view is strengthened by the influence of heating as already noted.

2. Sources of Pathogenic Organisms which may be Encountered in Milk.—First let us consider organisms derived from the producing animals:

(*a*) Cows.

1. The mammary gland.
   Mycobacterium tuberculosis.
   Virus of foot and mouth disease.
   Bacillus anthracis.
   Virus of cow pox.
   Streptococci.
2. From fecal contamination.
   Mycobacterium tuberculosis.
   Bacterium enteritidis

(*b*) Goats.

1. The mammary gland.
   Bacterium melitensis. (Malta fever).

Equally important are infective agents derived from human sources, thus:

1. Fecal and urinary discharges.
   Bacterium typhosus.
   Various non-specific organisms producing diarrhea.
2. Nasopharyngeal secretions.
   Mycobacterium diphtheriæ.
   Virus of scarlet fever.
   Streptococcus hæmolyticus. (Septic sore throat).

3. Development of Pathogenic Bacteria in Milk.—All of the rapidly growing pathogenic bacteria find milk a very favorable medium, consequently their numbers will increase. Thus individuals consuming contaminated milk will ingest large numbers of the organisms, in other words, the dosage of infection will be great. The extent to which multiplication takes place is modified by a number of factors among which may be mentioned the following: Germicidal property, temperature of storage, age of the milk and the time at which the infective agents gain introduction. Of these temperature is one of the most important. The nearer the temperature of storage approaches body heat the greater will be the development of pathogenic organisms.

The incidence of milk-borne disease in a given population is greatest among those who use milk as a beverage. A lighter incidence will be found among those who only employ milk on cereals, or as a diluent in tea, coffee or cocoa. Since women and children are usually the heaviest milk drinkers, the heaviest evidence of milk-borne disease is found in these age and sex groups. As we have seen, bacterial multiplication in milk is directly proportionate to the external temperature, consequently the dosage of infection in a given sample of infected milk will be greater in warm weather. As a rule milk-borne epidemics occur during the warmer seasons of the year, or following periods of warm weather in winter. The large dosage of infective agents received reduces the incubation period to its lower limits, but peculiarly, in the case of typhoid at least, the disease when milk borne is commonly milder than usual. In the care of typhoid and diphtheria transmission by milk it will be found that the contamination of the milk with these organ-

isms has been intermittent, frequently only a single lot being infected. Investigation will reveal the dairy or distributing agency responsible and the distribution of the cases will be found to coincide with the distribution of that supply. The possibilities in the contamination of milk and the range of its distribution are indicated in Fig. 64.

4. **Bovine Tuberculosis in Man.**—In the past widely divergent views have been entertained, from the belief that the bovine strain never affected man to the opposite view, that all human infection was derived from bovine sources. Such widely divergent views naturally stimulated research and as a consequence it is now possible to say with some degree of finality that the bovine tubercle bacillus is responsible for from 10 to 15 per cent. of all human tuberculosis, the clinical types produced being chiefly cervical adenitis, abdominal tuberculosis and generalized tuberculosis of alimentary origin. It is exceedingly rare in pulmonary tuberculosis, which is practically due only to the human strain of the tubercle bacillus. Infection is usually found in children under sixteen years of age, while susceptibility is greatest during the first five years of life.

In New York City 7 per cent. of the deaths among those of less than five years of age are due to bovine tuberculosis. Infection is contracted through the consumption of contaminated milk. When we consider the wide prevalence of the disease in cattle, as indicated by the following table and the small proportion of human infection, one must conclude that human infection is not very easy.

The bovine tubercle bacillus has been found in the following proportions in the milk supply of different cities:

New York City	16 per cent. of milk specimens examined.
Washington City	2.7-6.7 per cent. of milk specimens examined.
Chicago	7.9 per cent. of milk specimens examined.
Manchester, England	8.9 per cent. of milk specimens examined.

Tuberculosis is widespread among the dairy herds of the United States, though by constant effort, reduction is being gradually accomplished. A few years ago it was found that 302 of 421 dairy herds examined in the state of New York were infected. It has been authoritatively estimated that 30 per cent. of all dairy herds in the U. S. are infected.

The presence of tubercle bacilli in milk usually arises as a result of milk contamination with bovine feces. Mammary tuberculosis is very rare in cattle, only from 1 to 10 ten cent. of infected cattle having a tuberculous mastitis. On the other hand, pulmonary involvement is most common. The sputum instead of being expectorated is swallowed and the organisms pass out of the body with the feces.

Since the disease is chronic and the infection commonly widespread in invaded herds, it is easy to understand that the contamination of the milk from an infected dairy will probably be continuous. On the other hand, the tubercle bacillus is very slow growing, so that in the interval between production and consumption of the milk no appreciable increase in the number of organisms will take place.

Pasteurization of milk at a temperature of at least 60°C. is the only safeguard against milk-borne tuberculosis. Furthermore pasteurization should be in closed vessels to avoid the formation of the scum upon the surface of the milk which serves to insulate some of the organisms from the heat.

The tuberculin testing of dairy cattle and the slaughtering of those found to react is a very satisfactory means of eradicating the disease and has been successfully practiced for some time. This method, however, gives rise to serious losses in the case of blooded stock. To overcome this disadvantage the Bang system was originated. Reacting cows without open lesions are not killed, but are permitted to be bred. Following calving the calves are immediately separated from their mothers and never permitted to suckle. The cows are milked and the milk pasteurized before being fed to the calves. Of course the reacting cows used for breeding are separated from all other healthy cattle. The success of this method lies in the fact that intra-uterine infection is so rare as to be a negligible factor in the dissemination of the disease. As a consequence, the desirable qualities of highly bred cattle may be perpetuated and the losses are very much diminished, while healthy uninfected progeny are secured, and in the course of a few years a farm is clear of tuberculosis.

5. Milk-borne Typhoid Fever.—Since milk-borne typhoid fever was first recognized in 1857, over three hundred similar outbreaks have been reported in the literature and this must represent a minor fraction of the total.

Milk-borne typhoid is urban rather than rural in character and is probably responsible for a considerable proportion of

endemic typhoid, represented chiefly as small epidemics. Ogan estimates that 39 per cent. of all typhoid fever in New York City is milk-borne. In Washington City the minimum number of milk cases represent from 9 per cent. to 11 per cent. of all typhoid, these cases occurring chiefly in small epidemics. An interesting bit of data in this connection is the following observation from Washington.

TABLE VIII

Year	Pasteurization	Cases on milk routes per 100,000 gallons		
		Dealer 3	Dealer 4	Dealer 8
1906	none	16.6	52.5**	36.6
1907	none	7.1	21.6	17.1
1908	yes	5.8	10.1	18.8 *
1909	yes	1.4	7.0	6.9

** A pronounced milk outbreak.

* Not pasteurized until 1909.

These figures clearly indicate that milk is a considerable factor in endemic typhoid, and demonstrates the protective value of pasteurization.

In considering the introduction of the typhoid bacilli into the milk let us separately consider the dairy and the retail end.

Infection of the milk at the dairy or producing farm has been observed to have resulted from the following practices or circumstances in different epidemics (Fig. 64):

(*a*) Unrecognized cases serving as milkers or handlers.

(*b*) The nurse of a typhoid patient serving as a milker or milk handler (Fig. 63).

(*c*) Washing milk utensils in contaminated water.

(*d*) Washing milk utensils with the same dish cloths used for dishes of a typhoid case.

(*e*) Adulteration of milk with infected water.

From the standpoint of the distribution of a milk supply, the following circumstances have given rise to epidemics:

(*a*) Unrecognized cases or carriers delivering milk or working in milk depots.

(*b*) Use of bottles from premises on which typhoid cases existed without their previous sterilization.

The development of the typhoid bacillus in milk is rapid as

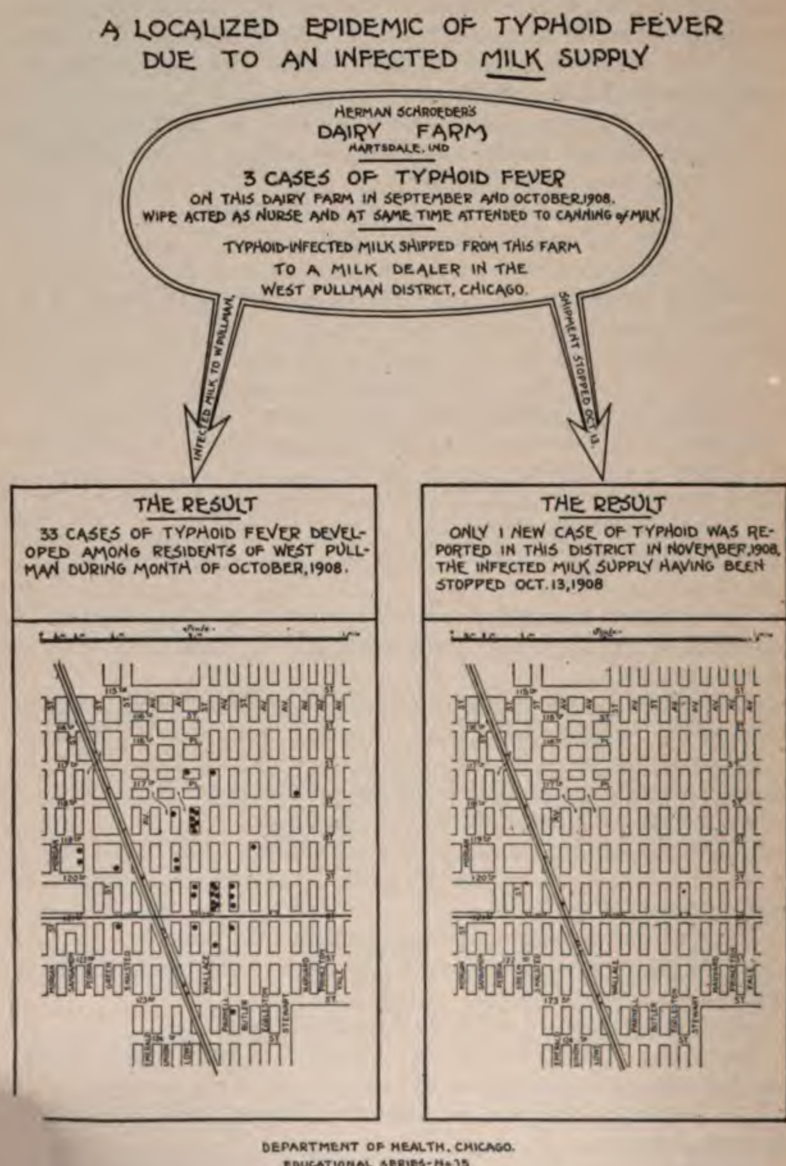
A LOCALIZED EPIDEMIC OF TYPHOID FEVER
DUE TO AN INFECTED MILK SUPPLY
HERMAN SCHROEDER'S
DAIRY FARM
HARTSDALE, IND
3 CASES OF TYPHOID FEVER
ON THIS DAIRY FARM IN SEPTEMBER AND OCTOBER, 1908.
WIFE ACTED AS NURSE AND AT SAME TIME ATTENDED TO CANNING of MILK
TYPHOID-INFECTED MILK SHIPPED FROM THIS FARM
TO A MILK DEALER IN THE
WEST PULLMAN DISTRICT, CHICAGO.
INFECTED MILK TO W. PULLMAN.
SHIPMENT STOPPED OCT. 13.
THE RESULT
33 CASES OF TYPHOID FEVER DEVELOPED AMONG RESIDENTS OF WEST PULLMAN DURING MONTH OF OCTOBER, 1908.
THE RESULT
ONLY 1 NEW CASE OF TYPHOID WAS REPORTED IN THIS DISTRICT IN NOVEMBER, 1908, THE INFECTED MILK SUPPLY HAVING BEEN STOPPED OCT. 13, 1908
DEPARTMENT OF HEALTH, CHICAGO.
EDUCATIONAL SERIES - No. 15

FIG. 63.

the temperature rises above ten degrees C. As a consequence most milk outbreaks occur during the summer months or during warm periods in winter. The outbreaks are explosive in character and affect milk drinkers most heavily, particularly women

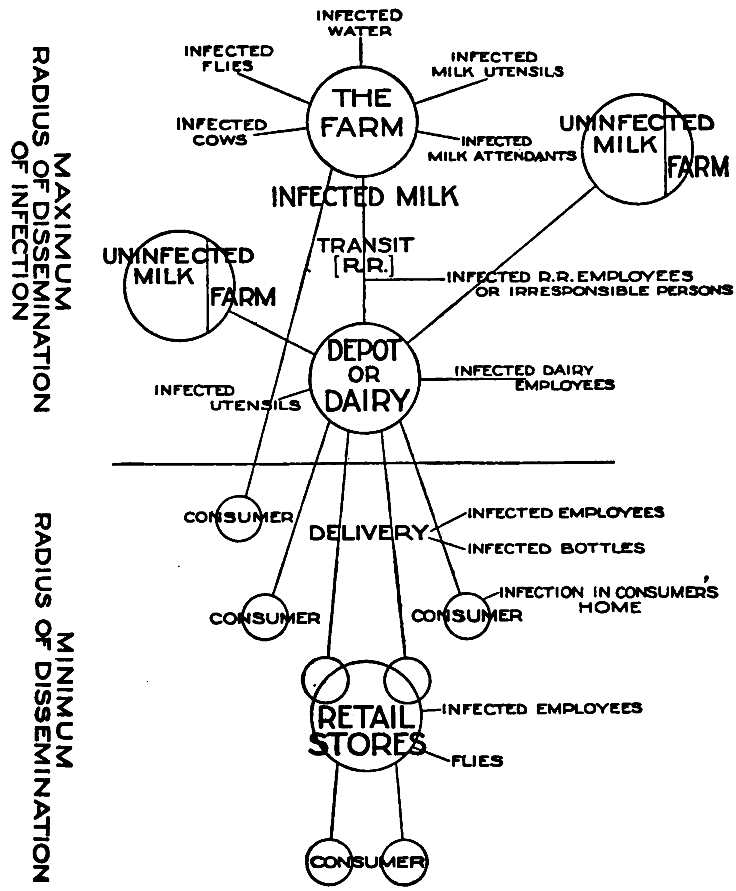

FIG. 64.—The distribution of infection by milk.

and children. The introduction of the infective agent is intermittent and as a result several explosive crops of cases may be observed.

6. Other Milk-Borne Infections.—The distribution of scarlet fever, diphtheria or septic sore throat by milk does not essen-

tially differ from that of typhoid fever, although they are of rarer occurrence.

7. Other Milk Products as Routes of Infection.—Dairy products, as well as fresh milk may serve to distribute infective agents. Thus the cream supply, ice cream, butter and butter milk must be borne in mind in the investigation of epidemics.

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CHAPTER XIX

OTHER FOOD STUFFS AS ROUTES OF INFECTION

We will now give a brief consideration to the other food-stuffs, exclusive of water and milk. In this connection it is apparent that some, such as meat, may serve both as a source as well as a route of infection.

1. Meat as a Vehicle of Infection.—The muscular tissue and certain viscera of cattle, sheep, swine, horses, dogs, and goats are largely consumed as food and constitute what we designate as meat. The animals slaughtered for this purpose may be diseased, in which event their meat may be unsuited for food for the following reasons:

(*a*) Infective agents to which man is susceptible may be present.

(*b*) The meat has an abnormal appearance and hence is repulsive.

(*c*) As a result of the illness the food value of the meat is lowered.

Furthermore careless methods of slaughtering may result in the contamination of the meat with micro-organisms from the intestinal tract, as a consequence of which decomposition takes place more rapidly.

Danger from such causes may be eliminated by a careful ante mortem inspection of the animals and a similar inspection of the carcass following slaughter. The presence of diseased tissue does not necessarily justify the condemnation of the entire carcass. Condemnation should be based upon an accurate diagnosis of the diseased conditions detected, and the extent of its distribution. Many diseased caracasses can be safely used in part as food. In the United States but little progress in meat inspection has been made. The Federal system of meat inspection is only for meats designed for interstate shipment and export. Meats slaughtered for local consumption can only be supervised by local authorities and very little has been undertaken in this direction.

(*a*) Diseases of animals which may be transmitted through meat:

1. *Meat Poisoning.*—By this term is meant a group of infections and intoxications due to the activity of several different organisms. The conditions are all highly acute and occur after a very brief incubation period, so that clinically they do not resemble typical infections. Bacterially we find the organisms concerned are *B. enteritidis*, *B. proteus*, *B. paratyphosus B.* and closely related forms, and also *B. botulinus*, whose action is due to highly potent soluble exotoxin. These outbreaks have usually been associated with the consumption of prepared meat foods (sausages, etc.) and pork has been the meat most commonly involved. These organisms are present in the gastrointestinal tract of the domestic animals and their presence in the meat is probably due to its contamination with the intestinal contents and feces after slaughter. The organisms of the enteritidis group are all killed by low degrees of heating (60 degrees for 30 min.), but they possess poisonous endotoxins which withstand a higher temperature.

2. *Verminous Parasites.*—Several cestodes and one nemotode are of considerable importance, the latter particularly. The beef tape worm, the pork tape worm and the fish tape worm all pass their larval stage in the flesh of the indicated animal and human infection with all is primarily derived from the consumption of parasitized meat. The pork tape worm possesses greater importance than the others, since an individual once infected can reinfect himself, as man can also serve as intermediate host. The most important parasite is the nematode worm, *Trichinella spiralis*, whose larval stage is commonly passed in swine. Human infection is derived from raw pork. It is undoubtedly the most common and the most important of all infections derived from meat.

3. *Other Infections.*—Tuberculosis, anthrax, rabies, glanders, tetanus and foot and mouth disease are all diseases of the food producing animals, transmissible to man, yet so far as we know, no cases are on record where human infection was contracted from the consumption of infected meat. Man is susceptible to all of these, but his infection is derived from different routes than meat.

3. Shell Fish as a Vehicle of Infection.—Oysters, clams, cockels or mussels are frequently secured from beds in bays, inlets, etc., that are contaminated by the sewage of large communities, or else floated in brackish water similarily contaminated (Figs. 65, 66). Thus opportunities are afforded for the shell fish to become contaminated with infective agents de-

rived from human excreta. A considerable number of typhoid epidemics have been ascertained to have been caused by the

FIG. 65.—Two oyster floats anchored in the rear of oyster houses. Privy vaults are located in the rear of these buildings, refuse being dumped directly into the river. It is a crime punishable by $100 fine to float oysters in this river. An epidemic of typhoid occurred some years ago from oysters floated in this place. (*Bull.* 136, *Bur. Chemistry.*)

FIG. 66.—A closer view of the upper oyster floats shown in Fig. 65. Note the pile of oysters in the float. Picture taken at low tide; about two hours later these same oysters were found in the adjoining oyster house ready for sale. Oysters drink best at the beginning of flood tide and are "plumpest" about one or two hours afterwards. The main sewer of the city empties under the bridge above. (*Bull.* 136, *Bur. Chemistry.*)

consumption of sewage contaminated oysters and clams. These observations have chiefly been made in England. The typhoid

bacillus will survive in oysters for as long as six weeks, and as changes of decomposition set in, will increase in numbers.

4. **Cooked and Canned Foods.**—For the most part hygienists have looked upon cooking as a process of distinct hygienic value, entirely apart from its influence upon the digestibility of food, for the application of heat will have a distinctly disinfecting action. However it now appears that not all cooking operations can be considered sufficiently thorough to altogether eliminate danger in cooked foods.

The greatest danger appears to exist where large lots of food are cooked at one time, for here the bulk of the material is so great that the interior is insufficiently heated and hence not sterilized. Furthermore bacterial spores can survive cooking or the canning process. Little positive epidemiological evidence is at present available concerning food as a route of infection.

Baked Spaghetti: An extensive outbreak of typhoid has been observed in California in which infection was derived from the consumption of a large dish of baked spaghetti prepared by a typhoid carrier. Experimentally it was found that in baking such a large dish that the typhoid bacillus could survive even though the exterior was charred.

Fried Fish: Several outbreaks of typhoid fever in London appeared to be due to the consumption of fried fish secured from sewage contaminated waters.

Botulism: Recently considerable evidence has been brought forward from the Pacific coast to the effect that the spores of *B. botulinus* can survive the process or canning. Several outbreaks of botulism due to the consumption of home canned vegetables have been reported. Outside of this area botulism is practically unknown in this country. The European outbreaks have occurred in connection with the consumption of pork sausage.

On the other hand, commercially canned foods have not until recently been implicated in botulinus intoxication. A few instances of cans of contaminated ripe olives which caused epidemics, have been noted. It would appear that commercially canned food from cans that are not obviously spoiled (swollen, leaky) are as safe as any foods available.

5. **Fresh Vegetables.**—A few outbreaks of typhoid have occured as the result of the consumption of raw fresh vegetables grown in gardens heavily manured with human excreta. In this

connection celery, lettuce, radishes and watercress have been incriminated.

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CHAPTER XX

INSECTS AS VECTORS OF INFECTIVE AGENTS

Two types of the insect transmission of infective agents are discernable, namely biological and mechanical.

1. **Biological Transmission.**—In this group transmission of the infective agent is accomplished by the aid of some blood sucking arthropod in whose body certain definite stages of the infective agents' life cycle are passed. So far as known the infective agents transmitted by this means have no other means of transmission.

Biological transmission of the parasites producing the following diseases is certain, namely; Malaria, Yellow Fever, Sleeping Sickness, Rocky Mountain Spotted Fever, Chagas' disease, Relapsing Fever, Typhus Fever, and Kala Azar. It is probably the usual means of transmission of Filiariasis and Dengue. The parasites concerned in this method of transmission are quite diverse, though apparently all belong to the animal kingdom. Thus we have protozoa, filterable viruses and nematodes. The groups of arthropods concerned are also quite diverse, although they all have the common habit of sucking blood, as for example; mosquitoes, biting flies, biting bugs, ticks, and lice. These arthropods are either temporary or permanent ectoparasites of mammals, living a life more or less intimately connected with the mammalian species upon which they prey.

The infective agents concerned undergo only an asexual multiplication in their vertebrate host, hence the vertebrate is known as the intermediate host. On the other hand, sexual development takes place in the arthropod which is known as the definitive host. The relation of the infective agents to the arthropod species concerned in their transmission is usually specific or nearly so. Where not specific we find that only closely allied species of arthropods are involved. Similarly we may find a high degree of specificity on the part of the infective agent and the vertebrate host, although in some instances several species of mammals may apparently serve equally well.

The influence of temperature and rainfall is noticed in the

distribution and prevalence of these diseases, due to the effect which these climatic factors exercise upon the breeding opportunities of the insects and hence influence their abundance. Temperature also profoundly influences the development of the protozoan parasites within their insect hosts, for example the distribution of malaria is limited by the annual isotherm of 60 degrees F. due to the inability of the malarial parasites to develope in the mosquitoes at a lower temperature. Thus low temperature may even inhibit protozoan development or sterilize the insect altogether. On the other hand, with favorable conditions of temperature it would appear that infection of the insect is usually permanent.

With infective agents whose transmission is biological, a definite lapse of time must occur before an insect which has become infected can transmit the infective agents to the host upon which it feeds. This period of noninfectivity is known as the extrinsic period of incubation and represents the time necessary for the infective agent to complete its sexual cycle in the insect and reach the appropriate point of exit.

The routes by which the mature infecting forms of the infective agents leave their arthropodal hosts varies with different species. In the case of trypanosomes present in Tse-tse flies, departure is by the food canal of the probosis; in the cases of the malarial parasites in the anophelines the departure is by the salivary ducts in the probosis; with the spirochetes of relapsing fever in either lice or bedbugs the departure may be either with the feces through the anus, or by liberation from the body cavity when the insect is crushed. In some few species hereditary infection of the insect host is known, thus for example the piroplasms of Texas Fever pass to the ovaries and young ticks are congenitally infected. The same also occurs in African Relapsing Fever.

As already noted the infectivity of the definitive arthropodal host is influenced by : (1) external temperature, which controls the development of the parasite within the insect; (2) The digestive processes of the insect, which may unfavorably influence the parasites; and (3) the presence and number of mature sexual forms of the parasites in the blood of the vertebrate upon which the insect has fed. Each feeding only removes a very small quantity of blood and unless the parasites are sufficiently numerous in the blood abstracted and both sexual forms are present, infection of the insect will not occur. All the chances are against the parasite. Thus we can understand that fre-

quently only one or two per cent. of anopheline mosquitoes will show malarial parasites, yet under more favorable circumstances where heavy gamete carriers are abundant, as many as 20 to 25 per cent. of mosquitoes will be infected.

The ability of any insect transmitted infection to gain a foothold and maintain itself requires at least two conditions: (1) That the definitive insect host exist in a certain degree of abundance, and (2) That intermediate mammalian hosts harboring the transmitting stage of the parasite be accessable to the insects. Thus the eradication of malaria can be accomplished without absolutely exterminating all anophelines in an area, by reducing their numbers to such a point that very few if any anophelines will have an opportunity to bite a gamete carrier.

2. **Mechanical Insect Transmission.**—Transfer of infective agents by this means may either be through the assistance of biting or sucking insects. The diseases in which the mechanism is more or less clearly understood are all due to bacterial infective agents. The relationship of the insect and parasite is not specific, that is the parasite can be transferred from man to man by other agencies and frequently those other agencies are of greater importance in the propagation of the different diseases than the insects. The presence of infective agents in or on the insect is more contaminative in character, the insect relationship does not play any essential part in the life cycle of the parasite and commonly we find that the insect can immediately transfer infection after having had an infective meal. In other words an extrinsic incubation period is not observed. Temperature and humidity exercise a similar influence upon the development of the insect vectors of this group, and their influence is thus exerted and manifested in the seasonal and climatic distribution of these diseases, or else influence the bacterium within or upon the nsect. The diseases whose infective agents may be transmitted by this means are plague, cholera, typhoid, and both bacillary and amœbic dysentery. Fleas are concerned in the transmission of plague, and flies, principally the house fly, in the transmission of the others. In the case of the former, the plague bacillus leaves the flea's body both by the probocis and the feces; in the case of the latter group, the flies' probocis, its excreta, regurgitated material and the exterior of its body surface may afford means of conveyance. In the former instance the infective agents are directly reintroduced by the insect into a new host, in the latter trans-

mission is effected through the contamination of food by the insect.

3. The Activity of the House Fly.—The house fly (*Musca domestica*) (Fig. 67) is an ubiquitous insect with a world wide distribution, living in close association with man. Its ova are preferably deposited in manure piles, from these hatch the familiar maggots (Fig. 68), which burrow through the pile and feed on the decaying organic matter. In about a week in the summer these leave the manure and burrow in the soil

Fig. 67.—The house fly. (*Public Health Reports, Supplement* 29.)

where they pupate. In a few days the adult fly emerges. The entire life cycle may be completed under favorable circumstances in from 10 to 14 days. The dangers arising from this insect are due to its promiscuous feeding habits and its intimate association with man. It will walk over and feed upon the fecal deposits in a privy, the refuse in a garbage can, the pastries in a bake shop and the food in the kitchen and pantry with equal impartiality and in turn, conveying infective agents secured from the excreta to food during its journey. There is absolutely no question but that in unsewered cities and towns

or in rural areas where fly tight privies are not used, flies are a great menace and an actual source of danger. They are undoubtedly a considerable factor in the autumnal increase in typhoid. A very marked reduction in the incidence of typhoid fever was secured in Jacksonville, Florida following systematic efforts at fly elimination through prevention of breeding, the extension of the sewer system and the substitution of fly proof provies for open closets. Prior to 1910 there were about 8,500 privies in Jacksonville, which accommodated about 40 per cent. of the population. They were distributed uniformly over the entire town. None were fly proof in the slightest.

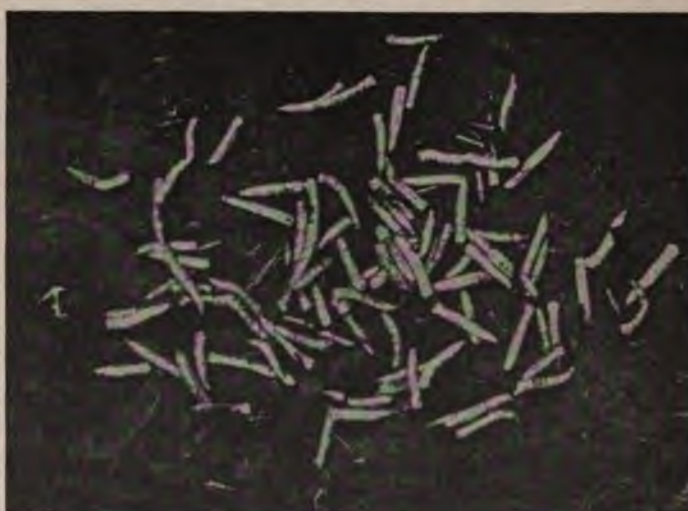

FIG. 68.—Larvæ, or maggots, of the house fly. About natural size (*Newstead*). (*Farmer's Bull.* 851.)

The typhoid cases annually reached a maximum in the fly season, while water and milk could be eliminated as a cause. In 1910 there were 329 reported cases with 62 deaths. Late in 1910 an ordinance was passed requiring the fly proofing of all privies, a requirement that was completely met before the season of 1911. During 1911 there were 158 reported cases and 40 deaths and in 1912 87 cases with 16 deaths. Of the 11 cases 88 received infection outside of Jacksonville, *i.e.*, e imported and of the 1912 cases 48 were imported. Later rs continued to show the same results. This recalls the rience with fly borne typhoid in the southern army camps

during the Spanish war, in which, however, the role of the flies was not recognized until serious losses occurred.

Dysentery bacilli may survive in flies for as long as five days, and typhoid bacilli may similarily survive nearly seven days. This relates to the organisms in the flies intestinal tract, from which they are discharged in the excreta (fly specks) or by regurgitation, though on the external surface of the body their survival is brief.

Difficulties with flies can best be overcome by the elimination of their breeding place, namely manure piles. These if open and exposed should not be permitted to represent over a weeks accumulation. Stables should have tight floors and be well cleaned. The removal of manure at weekly intervals will remove the partially developed maggots therein and afford local relief, but however, merely transfer the difficulty to some other situation. Another, but more expensive method, involves the keeping of flies from manure by requiring its storage in fly tight bins or boxes. Another solution to this problem is afforded by the treatment of manure piles with substances which destroy the larvæ. Substances must be used which are not too expensive. Borax may be used at the rate of 0.62 pounds of borax per 8 bushels of manure, but the treated manure may have an injurious effect on vegetation. Powdered hellebore, using one half pound to 10 gallons of water and applying this amount to each 8 bushels of manure is perhaps the most effective and practical substances to use for this purpose. Trapping and otherwise catching the adult flies, particularly if practised at the beginning of the breeding season, is of distinct merit. Sticky fly paper and the swatter should be used in every home and eating house. Dwellings and eating houses should be screened, and food displayed at retail, particularly that eaten without further heating, should also be screened.

Traps of different kinds are in vogue, some of which are designed to be placed near doors, where flies seek ingress, others over garbage cans or manure boxes, are all of value. Unless attention is paid to the breeding places however, traps are of slight service. Garbage accumulations should receive attention similar to manure.

The activity of flies as conveyers of infective agents from excreta gives opportunity to reiterate the importance of collecting human excreta in privies that are of fly tight construction.

4. Insecticides.—Various methods are available for the destruction of insects within dwellings, buildings, vessels, and other enclosed spaces. Their destruction by gaseous poisons is the

most satisfactory method, and is generally applied for the purpose of destroying either the types which have a closer parasitism, such as fleas, or bed bugs, or noxious types such as clothes moths, cockroaches, or vectors which may be present on the premises from which a case of plague, yellow fever, etc., has been removed and hence are potentially infected.

For this purpose either sulphur dioxid or hydrocyanic acid gas are commonly employed. The employment of gaseous insecticides demands that the quarters to be freed of insects be given the same preparation as that required for disinfection. When employed as an insecticide, it is not necessary that water vapor be employed with the burning sulphur, as anhydrous SO_2 is effective. For this purpose two pounds of sulphur are required for each 1000 cubic feet of space. Crushed sulphur sticks or flowers of sulphur should be employed. The required amount of sulphur should be placed in a conical pile in a very shallow cast iron pot, which is supported on bricks in a tub of water. A small depression is made in the summit of the pile in which is placed a ball of waste or cotton saturated with alcohol. When all other preparations are completed the alcoholic cotton is ignited and the operator immediately makes his escape. The quarters should remain closed for from 2 to 12 hours. The objectionable features of sulphur dioxid have been noted in the consideration of disinfectants.

A more satisfactory insecticide is hydrocyanic acid gas. It however is exceedingly poisonous to all mammals and man and should only be employed by one who is thoroughly competent and who fully understands its dangers. The gas is liberated from either sodium or potassium cyanid by means of sulphuric acid. Per 1000 cubic feet of the following proportion of these are required:

K C N	10 oz.
H_2SO_4	15 oz.
H_2O	22.5 oz.

Place the required amounts of acid and water in a glazed earthen ware jar, observing the usual precautions in the mixing. Complete all other preparations and be ready to make a hurried exit. Have the cyanid wrapped in a paper and drop it in the jar and instantly leave the room. Keep the quarters closed at least one hour. If several rooms are to be treated some arrangement with slings should be devised for lowering the cyanid into the acid from the outside.

Both cyanid and SO_2 are also employed for the destruction

of rodents. In maritime quarantine the exhaust gas from gasoline engines or the funnel gas from burning coal are also employed, due to the large content of carbon monoxide present. For small rooms or infrequent treatment it is not practical.

Another substance of great value for this purpose is carbon bisulphid, but whose wide employment is limited owing to its inflammable and explosive qualities. Carbon bisulphid volatilizes rapidly and is fully as explosive as ether. The gas is heavier than air. It is best adapted to the treatment of clothes rather than rooms and is preferably employed in small air tight closets or chests. It should be allowed to volatilize in the proportion of one pound per 100 cubic feet. The container from which it evaporates should be placed at the top of the enclosed space. It should be allowed to act for 10 to 12 hours.

Insect powders have some value, particularly those composed wholly or in part of dried pyrethrum flowers. These are burnt, or diffused through the air as a powder. The vapor or dust stupefies the insects so they fall to the floor and may be removed by sweeping. Pyrethrum is not injurious to man.

The body louse, because of its intimate relationship to man, cannot be altogether controlled by fumigation unless the clothing of all infected individuals is fumigated at the same time. For the delousing of clothing and bedding, physical agents give better results than fumigants, although in emergency work circumstances will largely control ones' efforts. Streaming steam will kill both adult lice and nits in 20 minutes and dry heat for 20 to 30 minutes at 60 degrees C. will also destroy adults or nits. Simultaneous attention must be paid to lice on the person, particularly in the hair. The old standby of kerosene and vinegar is probably best for this purpose.

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CHAPTER XXI

DISEASES TRANSMISSIBLE BY INSECTS

MALARIA

1. *Infective Agents.*—(*a*) *Plasmodium vivax*, causing simple tertian fever.

(*b*) *Plasmodium malariæ* causing quartan fever.

(*c*) *Plasmodium falciparum*, causing malignant tertian or estivo-autumnal fever.

2. *Source of Infection.*—Human beings whose blood contains tne gametes or sexual forms of the parasites, either those having acute or chronic malaria, or merely carriers.

3. *Portal of Exit.*—Blood abstracted by anopheline mosquitoes.

4. *Route of Transmission.*—Through the agency of anopheline mosquitoes which have bitten persons whose blood contains gametes. The sexual cycle of the parasite requires about 12 days for completion in the mosquito, at the end of which period the infecting forms (sporozoites) have made their appearance in the salivary glands (extrinsic period of incubation). In the United States there are three species of anopheline mosquitoes which can serve as vectors namely *Anopheles quadrimaculatus* (*maculipennis, syn.*) (Fig. 69, 73), *Anopheles punctipennis* and *Anopheles crucians*. Their ova, (Fig. 70) are most commonly deposited in open collections of water distant from dwellings, although they may be found in rain barrels, cisterns, etc., near homes. The adults are nocturnal in their habits. Only the females are blood suckers and hence only the females transmit malarial parasites. External temperatures below 15 to 16 degrees C. will inhibit the development of the parasite in the mosquito. Of the three species the quartan can develope at the lowest temperature, while the æstivo-autumnal requires the highest. Adult mosquitoes that successfully hibernate are rendered sterile. Infection is maintained by human gamete carriers. So far as is certainly known mosquitoes are not hereditarily infected.

5. *Portal oj Entrance.*—Sporozoites are liberated in the subcutaneous tissues or capillaries by the discharge of the salivary secretions of infected mosquitoes when biting.

6. *Incubation Period (Intrinsic)*.—The duration of this period is influenced by the external temperature, being shorter during

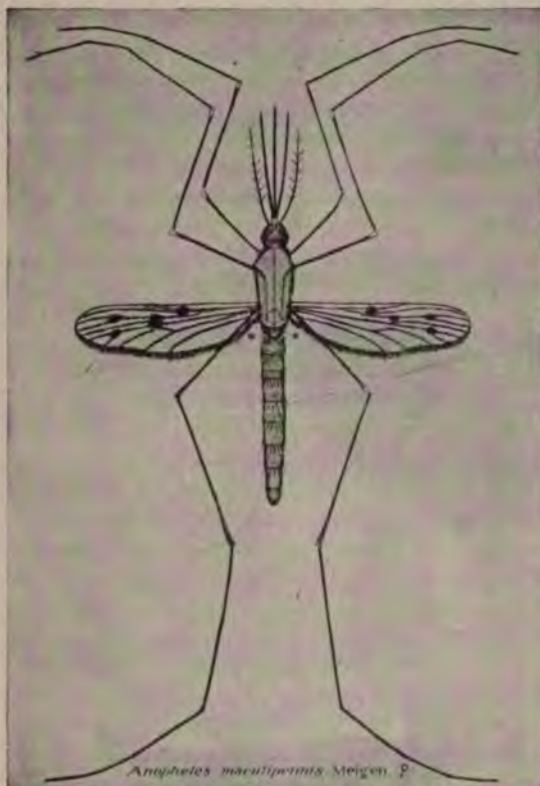

FIG. 69.—Anopheles maculipennis. (*Ludlow: Bull. 4. Surgeon General's Office. War Dep't.*)

FIG. 70.—Egg of anopheles, dorsal view. (*After Nuttall and Shipley.*) (*Doane: Insects and Disease, Henry Holt and Co.*)

high temperatures. It is usually about two weeks with *Plasmodium vivax*. The length of time following the onset before

gametes appear varies with the different species. Thus, in Tertian, from 8 to 20 days; Quartan, 11 days (for one observation); Malignant tertian, from 10 to 35 days.

FIG. 71.—Anopheles larvæ, the one to the right feeding, the other just coming to the surface. (*Doane: Insects and Disease, Henry Holt and Co.*)

FIG. 72.—Anopheles pupæ resting at surface of water. (*Doane: Insects and Disease. Henry Holt and Co.*)

FIG. 73.—Malarial mosquito (*A. maculipennis*) on the wall, showing the resting posture characteristic of Anophelines. (*Doane: Insects and Diseases. Henry Holt and Co.*)

In temperate climates infection is maintained not by the survival of the infected mosquitoes through the winter, but by the reinfection of the mosquitoes from human gamete carriers in the spring.

7. *Period of Communicability.*—As long as gametes are present in the circulation. This may be indefinitely.

8. Methods of Control. *The Infected Individual (Active Malaria).*—(*a*) Diagnosis: Clinical manifestations, always confirmed by detection of the parasites in the blood.

(*b*) Isolation: Protection of the patient from mosquitoes until his blood is free from parasites, especially gametes, by the use of screens or bars.

(*c*) Immunization: None.

(*d*) Quarantine: None.

(*e*) Concurrent Disinfection: None as such. Destroy by capture or swatting all mosquitoes in the sick room.

(*f*) Terminal Disinfection: Same as before.

General Measures.—(*a*) Search for gamete carriers by the examination of blood smears. Intensively treat such persons with quinine until sterilized. For adults Bass recommends 10 grains of quinine sulphate every night before retiring, continued for 8 weeks This treatment will destroy the parasites in 90 per cent. of the carriers. The remaining 10 per cent. should receive 3, ten-grain doses a day for three or four days and later 10 grains a day for eight weeks. Infants and children should be dosed as follows:

Under 1 year	0.5 grain
1 year	1.0 grain
2 years	2.0 grain
3 to 4 years	3.0 grain
5, 6 and 7 years	4.0 grain
8, 9 and 10 years	6.0 grain
11–14 years	8.0 grain
15 years	10.0 grain

(*b*) Prophylactic administration of quinine: The daily administration of 3 grains of quinine will prevent infection from developing. Where employed on a large scale provision must either be made for its distribution gratis or at a very low charge.

(*c*) Destruction of mosquito breeding places, by:

1. Drainage (Figs. 76, 77).
2. Training of water courses, or by
3. Filling.

Attention should be paid to all depressions both natural and artificial, and of either stagnant or running water within one half mile radius of the area where control operations are being prosecuted.

The planting of eucalyptus trees in swampy wet areas that for one reason or another cannot be drained, has been recommended, but their value for this purpose is undetermined. They apparently accelerate the evaporation of the swamp water.

(*d*) Destruction of Mosquito Larvæ. Two methods may be used.

FIG. 74.—Oilers at work in marsh. (*Gorgas, "Sanitation in Panama," Appleton's.*)

1. The application of a thin iridescent film of oil to the surface of water areas it is not feasible to drain, at least after every rain. The oil is either sprayed from knapsack sprays, or fed by drip cans. The latter are only adapted to streams or ditches conveying running water. Crude oil is best (Figs. 74, 75).

3. Stocking swamps and pools with species of fish that are predatory upon mosquito larvæ. The Public Health Service is introducing the employment of the top minnow, *Gambusia affinis*, for this purpose.

2. The application of solutions having a lethal action on the larvæ, such as the "Larvacide" of Darling. This is prepared

from crude carbolic acid of a sp. gr. not greater than 0.97 and containing not less than 30 per cent. tar acids. One hundred

FIG. 75.—Burning out ditch with oil spray. (*Gorgas, "Sanitation in Panama," Appleton's.*)

FIG. 76.—Prolific source of anopheles, horse-lot drain, Crossett. (*Derivaux, Taylor and Hess, P. H. Bull.* 88, *U. S. P. H. S.*)

and fifty gallons of the phenol are heated in a tank and to this 200 pounds of finely crushed and sifted rosin are added and also 30 pounds of caustic soda dissolved in 6 gallons of water. This

is well mixed. For use a 1:5 dilution in water is made. This is sprayed on water accumulations until the water has a thin milky opalescence (about 1:5000).

In applying either oil or larvacide especial attention must be given to the margins and weedy places in the streams and pools. Depending upon the degree of agitation and the amount of fresh water introduced by rain, etc., repeated application of these will have to be made at irregular intervals.

(*e*) Destruction of Adult Mosquitoes: 1. Adult mosquitoes may be naturally destroyed by the encouragement of various natural predaceous enemies, such as bats, dragon flies, etc. These alone, however, will not suffice.

FIG. 77.—Same as Fig. 76, after treatment. (*Derivaux, Taylor and Hess. P. H. Bull.* 88, *U. S. P. H. S.*)

2. Swatting or trapping of adult mosquitoes in dwellings: They prefer to hide in dark corners during the day, where patient search will soon result in their discovery. One may also fumigate by burning pyrethrum.

(*f*) Exclusion of adult mosquitoes from dwellings.

Screening is the best method of accomplishing this result. A fine mesh screen of at least 19 to 20 strands per inch should be employed. All external openings should be screened, including windows, doors, fireplaces, or chimneys, cracks, etc. If possible verandas or galleries should be screened, rather than to limit one's efforts to the windows and doors leading out upon them. Doors may be protected by screened vestibules if necessary. In the absence of screening bars should be provided for all beds.

Screening and the control of mosquito breeding on the living premises are remedies available to every householder. On the other hand, the elimination of areas of extensive breeding is an effort that requires concerted community action. The methods or combinations of methods required to meet local conditions will vary, and require the exercise of considerable judgment. The question of initial cost and maintenance costs will likely be factors that largely influence the permanency of the efforts. At Havana, Panama, Ismailia and a few other places, the importance of mosquito control to the authorities was such that expense was not considered in securing the desired result. On the other hand, the control of malaria in the southern United States is a problem that will only be solved by methods that are within the slender resources of the average rural community. The possibilities in this direction have been brilliantly demonstrated by the work of Dr. H. A. Taylor in a group of rural towns in south eastern Arkansas. In the four towns in which antimosquito measures were undertaken in 1918, there was an average reduction in the incidence of malaria of 89 per cent. The operations included the cutting of new drainage ditches where necessary, the recleaning and regrading of old streams and the oiling of all accumulations of water not possible to drain. This was accomplished at an average per capita cost of eighty eight cents. The work requires careful and intelligent supervision.

YELLOW FEVER

1. *Infective Agent.*—Probably the spirochete (*Leptospira icteroides*) reported by Noguchi.

2. *Source of Infection.*—Typical and atypical cases of yellow fever, possibly only during the first three days of their illness.

3. *Portal of Exit.*—Blood abstracted by *Stegomyia fasciata* (*Aedes calopus*) (Fig. 78).

4. *Route of Transmission.*—So far as known only by the agency of one species of mosquito, *Stegomyia fasciata*, which has fed upon the blood of yellow fever patients. The unknown parasite undergoes an extrinsic incubation period in the mosquito of at least 12 days before the mosquito can transmit the virus.

5. *Portal of Entrance.*—Through the puncture wounds in the skin made by mosquitoes, to the subcutaneous tissues.

6. *Incubation Period.*—(Intrinsic) from three to six days.

7. *Period of Communicability.*—Probably only during the first three days of the illness.

8. Methods of Control. *The Infected Individual.*—(*a*) Diagnosis: Clinical observations only.

(*b*) Isolation: In a well screened room or ward which has been freed of mosquitoes.

(*c*) Immunization: None.

(*d*) Quarantine: Of contacts for six days.

(*e*) Concurrent Disinfection: None.

(*f*) Terminal Disinfection: Fumigate to get rid of mosquitoes.

General Measures.—(*a*) Eradication of mosquitoes by measures described under malaria. Since the habits of Stegomyia differ from those of anophelines, some difference in the water accumulations attacked must be noted. The Stegomyia is a species that lives closely in association with man, breeding largely

FIG. 78.—The yellow-fever mosquito: Adult female, side view. Much enlarged. The silver and black markings give the insert a very striking appearance. Note the silver crescents on the thorax. (*Howard: Farmer's Bull.* 547.)

in artificial accumulations of water close to dwellings, such as cisterns, barrels and cans (Fig. 79). It is diurnal in its first feeding and later nocturnal. It is never found in marshes or swamps, so that attention need not be given to these unless a simultaneous attack on malaria is also desired

Epidemic Measures.—(*a*) Inspection service to detect unreported cases.

(*b*) Fumigation of houses in which cases have occurred, and also of the adjacent houses.

(*c*) Removal of patients to screened isolation hospitals.

DENGUE

1. *Infective Agent.*—Unknown.

2. *Source of Injection.*—So far as is known only typical and atypical human cases.

3. *Portal of Exit.*—In the blood abstracted from patients.

4. *Route of Transmission.*—By agency of mosquitoes (*Stegomyia fasciata*) which have fed upon dengue patients. The extrinsic incubation period is unknown.

5. *Portal of Entrance.*—Through puncture wounds made by mosquitoes in the skin, into the subcutaneous tissues.

6. *Incubation Period.*—From four to five days (intrinsic).

7. *Period of Communicability.*—Probably as late as the eighth day of illness.

8. Methods of Control. *The Injected Individual.*—(*a*) Diagnosis: Clinical manifestations.

(*b*) Isolation: In a screened room.

(*c*) Immunization: None.

(*d*) Quarantine: None.

(*e*) Concurrent Disinfection: None.

(*f*) Terminal Disinfection: Fumigate to get rid of mosquitoes.

General Measures.—Same as for Yellow Fever.

TYPHUS FEVER

1. *Infective Agent.*—Unknown.

2. *Source of Infection.*—Typical and atypical human cases.

3. *Portal of Exit.*—In blood abstracted from patients.

4. *Route of Transmission.*—By the agency of the human body or clothes louse, *Pediculus vestimenti* (Fig. 80). The virus appears to have an extrinsic incubation period in the louse of at least four days.

5. *Portal oj Entrance.*—Through puncture wounds in the skin made by lice, into the subcutaneous tissues.

6. *Incubation Period (Intrinsic).*—From five to twenty days, usually twelve days.

7. *Period oj Communicability.*—Probably until one or two days following the return of patient's temperature to normal.

8. Methods of Control. *The Infected Individual.*—(*a*) Diagnosis: By clinical manifestations. The Felix-Weil agglutination reaction is reported as of value.

(*b*) Isolation: Destroy all vermin on the body of the patient, transfer to vermin free clothing and place in a vermin free room. All attendants should wear vermin proof clothing.

(*c*) Immunization: None.

(*d*) Quarantine: Of those exposed, or of susceptibles for twelve days after last exposure.

(*e*) Concurrent Disinfection: None.

(*f*) Terminal Disinfection: Destroy all lice, together with their eggs, on the patient's body if not already done. Destroy

FIG. 79.—Screened water barrel, Havana. (*Gorgas, "Sanitation in Panama," Appleton's.*)

FIG. 80.—*Pediculus vestimenti.* L.: female (× about 25). (*Castellani and Chalmers, "Manual of Tropical Medicine," Wm. Wood and Co.*).

all vermin and eggs on the clothing returned to the patient. Free the isolation quarters of all vermin.

General Measures.—Delousing of persons, clothing and prem-

ises during epidemics, or when individuals have come into or have been brought into an uninfected place from an infected community. (Figs. 81, 82.)

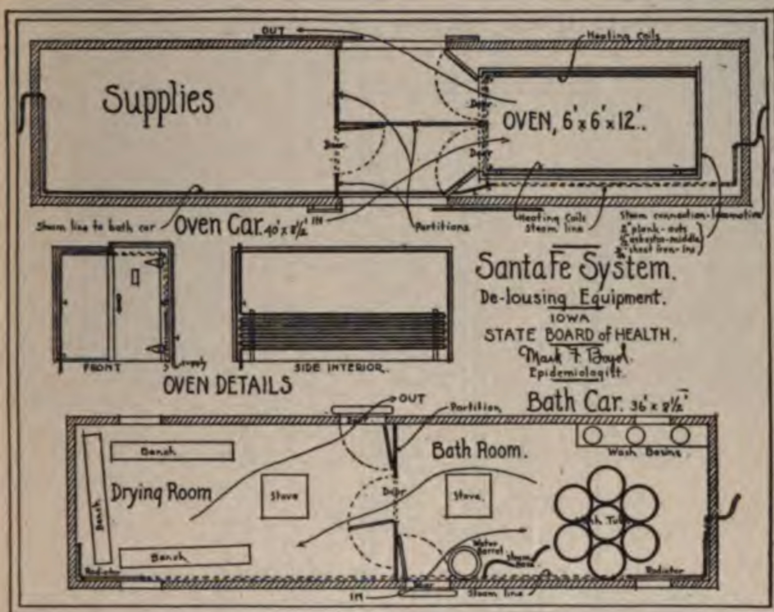

FIG. 81.—Delousing equipment of the Santa Fe Railroad. (*Am. Jour. Pub. Health*, 7–8.)

EUROPEAN RELAPSING FEVER

1. *Infective Agent.*—*Spironema recurrentis* (*Syn. Spirillum obermeirii*).

2. *Source of Infection.*—Typical and atypical human cases.

3. *Portal of Exit.*—In the blood abstracted from patients.

4. *Route of Transmission.*—By the agency of the common bed bug, *Cimex lectularius.* (Fig. 83). The duration of the period of extrinsic incubation is unknown. Possibly also by body lice.

5. *Portal of Entrance.*—Through puncture wounds made in the skin by bugs and lice, and also through abrasions made by scratching, into which have been rubbed the body juices of crushed bugs.

6. *Incubation Period.* (*Intrinsic*).—From two to twelve days.

7. *Period of Communicability.*—Unknown. Regard a patient as possibly infective until recovery is complete.

8. Methods of Control. *The Injected Individual.*—(*a*) Diagnosis: Clinical manifestations confirmed by the observation of the spirillum in blood smears taken during relapses.

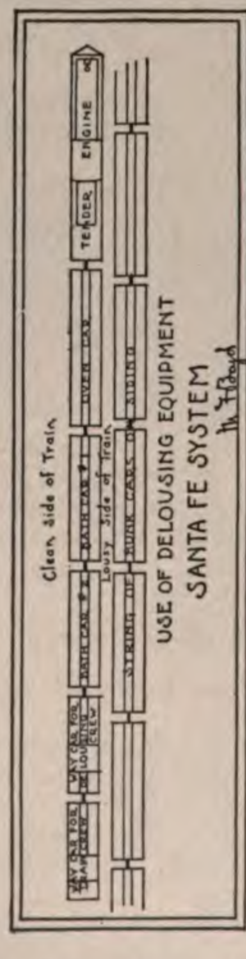

FIG. 82.—The delousing train was run alongside a string of bunk cars whose occupants were to be deloused. These cars were taken one at a time. The occupants took their clothing and bedding forward to the oven car and then went to the bath car. When undressed their clothing was sent to the oven, which was then closed and heated. The Mexicans then bathed in soap-suds and kerosene and awaited the return of their clothing via the opposite side of the train. Meanwhile a squad had been spraying the bunks in the bunk car with kerosene. (*American Jour. Public Health.*)

(*b*) Isolation: Same as for typhus.

(*c*) Immunization: None.

(*d*) Quarantine: Of exposed susceptibles for twelve days after the last exposure.

(*e*) Concurrent Disinfection: None.

(*f*) Terminal Disinfection: Same as for typhus.

General Measures.—Same as for typhus, extending the activities to include the bed bugs.

FIG. 83.—*Cimex lectularius.* *a*, Adult female, gorged with blood; *b*, same from below; *c*, rudimentary wing-pad; *d*, mouth-parts—all enlarged. (*Marlatt, Bull. 4, Div. Ent.*).

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CHAPTER XXII

LOWER ANIMALS AS SOURCES OF INFECTION FOR MAN

The lower animals, both wild and domesticated, suffer from a number of infections whose agents are transmissible to man. The more important are the following:

Frequency	Disease	Animal host
A. Transmission regular or at least frequent.	1. Bubonic Plague.	Rats, by the agency of fleas.
	2. Rabies.	Dogs and other carnivora.
	3. Anthrax.	Sheep, cattle and horses.
	4. Trichiniasis.	Swine.
	5. Malta Fever.	Goats.
	6. Rocky Mt. Fever.	Ground squirrels by ticks.
	7. Tape Worms.	Cattle, swine and dogs.
B. Transmission limited.	8. Cow pox.	Cattle.
	9. Bovine tuberculosis.	Cattle.
	10. Glanders.	Horse, donkey and mule.
	11. Paratyphoid.	Cattle and swine.
	12. Foot and mouth disease.	Cattle and swine.
	13. Fungi of favus and ring-worm.	Mice and cattle.

Because of their rarity in man, or their triviality as causes of mortality, we shall ignore certain of these infections and confine our attention to five. These infections are transmitted to man by varying routes, the only common feature being the fact that man is not the normal host of the infective agent.

PLAGUE (BUBONIC AND PNEUMONIC)

1. *Infective Agent.—Bacterium pestis.*

2. *Source of Infection.*—Typical and atypical plague (acute and chronic) in rats and other rodents, including the native ground squirrels in California. In pneumonic plague man

serves as the source of infection. The disease normally, however, is one of rodents.

3. *Portal of Exit.*—The blood of infected rats abstracted by fleas, or the sputum of pneumonic plague patients.

4. *Route of Transmission.*—In bubonic and septicemic plague the bacillus is conveyed from rat to man or from rat to rat or other rodent, by the agency of either the tropical rat flea (*Loemopsylla cheopis*) or the temperate zone rat flea (*Ceratophyllas fasciatus*) (Fig. 84). Their action is purely mechanical. The plague bacilli produce an intestinal obstruction in the flea, so that an infected flea when attempting to feed regurgi-

FIG. 84.—The European rat flea (*Ceratophyllus fasciatus*): adult female. Greatly enlarged. (*Bishopp: Bull. 248. U. S. Dept. of Agriculture.*)

tates plague bacilli from his stomach into the punctured wound. Bed bugs (*Cimex lectularius*) may also transmit the bacilli.

In pneumonic plague the bacilli are transferred from man to man by direct or indirect contact.

5. *Portal of Entrance.*—The fleas may introduce the bacilli into the subcutaneous tissues of any part of the body, usually into the lower extremities.

In pneumonic infection the bacilli are introduced into the body either through the mouth, nose or conjunctiva.

6. *Incubation Period.*—Commonly from three to seven days, though sometimes prolonged to eight or even fourteen days.

7. *Period of Communicability.*—(*a*) Man: Until convalescence is well established, period undetermined.

(*b*) Rat: In chronic or latent cases the infectivity may be prolonged, but the period is uncertain.

8. **Methods of Control.** *The Infected Person.*—(*a*) Diagnosis: Clinical manifestations confirmed by bacteriological examination of blood, glandular exudate or sputum.

(*b*) Isolation: 1. Bubonic plague: Hospitalize if possible, place patient in a vermin free, screened room.

2. Pneumonic plague: Rigid isolation must be employed and attendants must exercise great care for their own protection. Masks should be worn.

(*c*) Immunization: Yersin produced a serum by the injection of horses at first with a plague vaccine and later completing the immunization by the use of living cultures. The therapeutic value of the serum is appreciable. Active immunization with Haffkine's vaccine apparently confers protection. The Indian experience appears to indicate that the likelihood of subsequent infection after its use is reduced four fifths, while among the proportion who do contract infection, the chances of recovery are much increased. It should be administered to those persons whose activities favor their exposure.

(*d*) Quarantine: Of contacts for seven days.

(*e*) Concurrent Disinfection: Of all discharges and articles soiled therewith.

(*f*) Terminal Disinfection: Thorough cleaning followed by thorough disinfection.

General Measures.—(*a*) Extermination of rats and vermin within the infected area, paying especial attention to the brown or Norway rat by employing:

1. Fumigation with HCN, SO_2, CO or CS_2.
2. Trapping.
3. Poisoned bait.

(*b*) Rat exclusion.

1. By rat proofing homes, outhouses, and business buildings (Figs. 86, 87, 88, 89).
2. By removing accumulations of refuse in which rats can harbor, and of garbage upon which they can feed.
3. By exterminating rats on ships.
4. By preventing rats on ships from coming ashore, or those on shore from entering ships (Fig. 90). The marine migrations of rats, accomplished by the aid of shipping, have in the last twenty five years distributed plague over the entire world.

(*c*) Flea destruction by fumigation. This should be employed in infected foci.

FIG. 85.—General view of stable and junk house from second floor. Two plague rats were trapped here. On demolition 86 rats were killed. (*Public Health Reports.*)

FIG. 86.—Model showing construction details which permit rat infestation. (*Suppl. 27, Public Health Reports, U. S. P. H. S.*)

(*d*) Delimitation of an infected area: General rat trapping operations should be carried out all over an infected area. All rats caught and all found dead should be examined for evi-

FIG. 87.—Rat-proofing lumber by elevation on concrete pillars. (*U. S. P. H. S.*)

dence of plague infection. The locality where each infected rat is found should be regarded as a focus of infection. Since

FIG. 88.—Site of human plague in Puerta de Tierra. Rat proofed by concrete walls and floor. (*P. H. Rep., June* 6, 1913.)

permanent measures of rat exclusion and eradication are expensive and procede slowly, it is not always practicable, in the face of existing plague, to enforce these generally with the hope

of eradicating the disease. A more practicable method is to confine the earliest operations, at any rate, to the infected foci

FIG. 89.—Site where a plague rat was found, after elevation. Building formerly tight to the ground. (*P. H. Rep., June* 6, 1913.)

FIG. 90.—The rat guards on the hawsers prevent rats entering or leaving the ship by this route. The ship should also be breasted from the wharf.

until the disease is brought under control. The method developed by Heiser in Manila for this purpose is as follows:

Five radiating equidistant lines are drawn from each point where a plague rat is found. Starting at the center, rat catching operations are carried out along each. The most distant points along each line at which plague rats are found are connected by lines. Thus the circumference of the infected area is outlined (See Fig. 90*a*). As a rule its radius is seldom more than a few blocks from the original focus. Rat catching is then begun along the periphery and proceeds toward the center, after

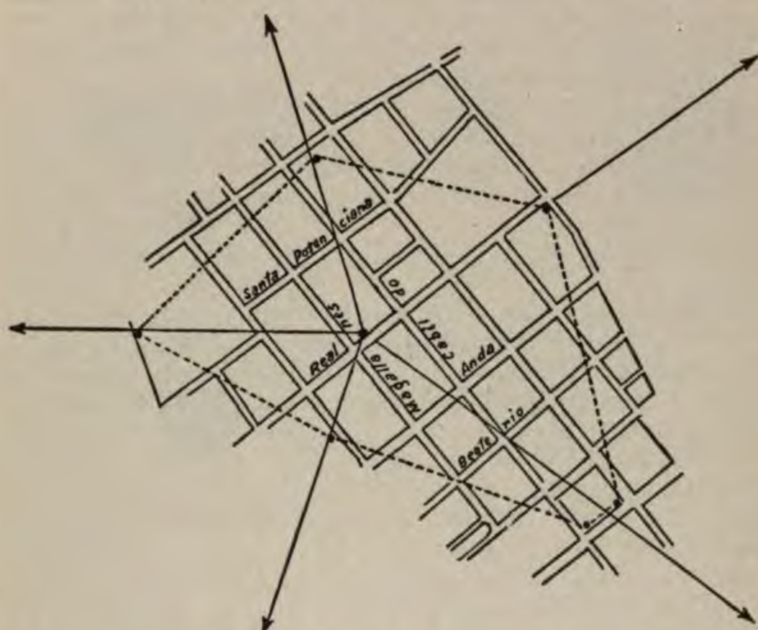

FIG. 90*a*.—Isolated plague-infested center, Manila, P. I. (*From Heiser; Rat and Public Health, U. S. P. H. S.*)

which rat proofing operations are begun at the periphery and proceeds centrally. Thus the rodents in each focus are exterminated and the place made uninhabitable for them. This method has not been employed in combatting plague in the United States.

(*e*) In California considerable effort is being made to eradicate the ground squirrels in infected rural areas by use of poisoned grain, trapping, and asphyxiation of the squirrels in their burrows by carbon bisulphide.

(*f*) House to house inspection for the detection of unreported cases may be necessary. All dying during the epidemic should be autopsied.

(*g*) Cremation or burial in quick lime is advisable.

ROCKY MOUNTAIN SPOTTED FEVER

1. *Infective Agent.*—Unknown.

2. *Source of Infection.*—Ground squirrels and other rodents of the western inter-mountain region of the United States.

3. *Portal of Exit.*—Blood of infected animals abstracted by ticks of the genus *Dermacentor*.

4. *Route of Transmission.*—By bites of ticks (*Dermacentor andersonii*, or *venustus*. (See Fig. 91), which have fed on infected ground squirrels. Probably a biological transmission.

5. *Portal of Entrance.*—Into the subcutaneous tissues through the bite wound.

6. *Incubation Period.*—Three to ten days, usually seven days.

6. *Incubation Period.*—Three to ten days, usually seven days.

7. *Period of Communicability.*—Unknown.

8. **Methods of Control.** *The Infected Person.*—(*a*) Diagnosis: By clinical manifestations in areas where the disease is known to be endemic.

(*b*) Isolation: None.

(*c*) Immunization: None.

(*d*) Concurrent Disinfection: None, but destroy any ticks that may be on the patient.

(*e*) Quarantine: None.

(*f*) Terminal Disinfection: None.

General Measures.—(*a*) The wearing of tick proof clothing by those in endemic areas, and following the practice of searching the body each day for ticks.

(*b*) Destroying ticks on limited zones in infected areas by clearing, and burning vegetation in rotation.

(*c*) Grazing sheep on infected areas. The ticks attach themselves to the sheep, become enmeshed in the wool and perish.

(*d*) Dipping of the other domestic animals of infected areas in arsenical solutions.

(*e*) Destruction of ground squirrels, chipmunks and other rodents in infected areas by poisoned grain, by CS_2 and by trapping.

FIG. 91.—The Rocky Mountain spotted-fever tick, *Dermacentor venustus*. 1. "Deposited-out" female with eggs. 2. Unengorged larva. 3. "Deposited-out" female, frontal view. 4. Engorged larva. 5. Engorged female, dorsal view. 6. Unengorged female, dorsal view. 7. Male, dorsal view. 8. Male, ventral view. 9. Unengorged female, ventral view. (*Hooker, Bishopp and Wood, Bull.* 106, *Bureau of Entomology, U. S. Dept. of Agriculture.*)

RABIES

1. *Infective Agent.*—Unknown, a filterable virus.

2. *Source of Infection.*—Typical and atypical cases and incubatory carriers in dogs, and other carnivorous animals.

3. *Portal of Exit.*—In the saliva of infected animals.

4. *Route of Transmission.*—Inoculation with the saliva of infected animals, through wounds or abrasions of the skin and mucosa, almost always by bites or scratches.

5. *Portal of Entrance.*—Through the subcutaneous tissue to the terminal nerve fibers.

6. *Incubation Period.*—Variable, seldom less than four weeks and occassionally six months or longer.

7. *Period of Communicability.*—For perhaps two weeks prior to the manifestation of symptoms and throughout the clinical course of the disease.

8. **Methods of Control.**—(*a*) *Diagnosis* (*in animals*).—Clinical manifestations of animals, confirmed by the finding of Negri bodies in the brain, or by successful animal inoculations with such a brain.

(*b*) *Isolation* (*of Patient*).—None, if patient is under adequate medical supervision and the immediate attendants are warned of the possibility of inoculation by human virus.

Animals which are suspected of being rabid and which have bitten or exposed a person to infection, should not be killed, inasmuch as the laboratory confirmation of the suspected diagnosis may be rendered difficult or time consuming. Such animals should be confined in rigid isolation and closely observed. If actually rabid, death will occur within ten days and the diagnosis can be confirmed by the clinical course and laboratory examination. If the animal is alive at the end of this period the question of rabies is eliminated. This precaution does not endanger the patient through too great delay in beginning the Pasteur treatment.

(*c*) *Immunization.*—The administration of active immunization (Pasteur treatment) after exposure to infection by inoculation. The Pasteur treatment should be administered under the following circumstances:

A. From a diagnosis of rabies in the biting animal based on one or more of the following data: (1) Clinical manifestations, (2) Negri bodies, (3) Inoculation, or,

B. On suspicion, where the biting animal is at large but manifested suspicious symptoms.

Various methods have been devised for the attenuation of the rabies virus, but those is most general use closely follow the technique developed by Pasteur. The rabic virus derived from carnivoræ is attenuated for man by successive passages through rabbits, until its incubation period becomes constant. It is then known as fixed virus, and has an incubation period of six to seven days when inoculated intracerebrally into rabbits. The spinal cord of a rabbit dying of fixed virus infection is aseptically removed intact and dessicated in a jar over sticks of caustic soda, producing a further attenuation. From day to day, up to the 8th day of dessication, pieces of dried cord representing about 1 cm. of the fresh cord are removed to glycerine and designated as one, two or three day cord, etc., according to the extent of the dessication to which they have been subjected. Under refrigeration, these remain potent about one month.

For administration the dried cord is further prepared as follows: A piece of the dried cord is washed in saline to remove the glycerine, and ground in a small mortar until homogenous. Then drop by drop two and five tenths c.c. of saline are added and thoroughly mixed with the cord until a homogenous sus-

SCHEMA OF THE PASTEUR TREATMENT

Day of treatment	Age of dried cord	Amount injected
1	8-7-6	2.5
2	4-3	2.5
3	5-4	2.5
4	3	2.5
5	3	2.5
6	2	2.5
7	2	2.5
8	1	2.5
9	5	2.5
10	4	3.5
11	4	2.5
12	3	2.5
13	3	2.5
14	2	2.5
15	2	2.5
16	4	2.5
17	3	2.5
18	2	2.5
19	2	2.5
20	3	2.5
21	2	2.5

For children the doses of the stronger viruses are reduced.

pension is secured. This is the material for injection. The site of election is the subcutaneous tissue of the abdominal wall, which is prepared by painting the skin with iodine.

With the vaccine distributed bythe U. S. P. H. S., the course of treatment covers twenty five injections given over a period of twenty one days. The schedule followed in the intensive treatment of adults is as given in the preceding table.

(*d*) *Quarantine.*—Of dogs transported from infected to uninfected areas for six months.

(*e*) *Concurrent Disinfection.*—Of patient's saliva and objects contaminated therewith.

FIG. 92.—Proper and improper muzzling of dogs. The muzzle on the right hand dog is ineffective, as it may be easily slipped from position. (*U. S. P. H. S.*)

(*f*) *Terminal Disinfection.*—Thorough cleaning.

General Measures.—(*a*) Muzzling of dogs when on public streets or in places to which the public has access (Fig. 92).

(*b*) Detention and examination of dogs suspected of having rabies. Detention should be maintained ten days. If death occurs search should be made for Negri bodies.

(*c*) Provision for the immediate anti-rabic treatment (active immunization) of persons bitten by dogs or other animals suspected or known to have rabies. The wounds should be cauterized with fuming nitric acid as soon after their infliction as possible.

ANTHRAX

1. *Infective Agent.—Bacillus anthracis.*

2. *Sources of Infection.*—Cases in cattle, sheep and horses.

3. *Portal of Exit.*—In extravasated blood.

4. *Route of Transmission.*—By the hair, hides and feces of infected animals or objects such as soil or dust, contaminated therewith. It must be borne in mind that this is a spore forming organism which can survive the action of sunlight and desiccation for prolonged and indefinite periods, such as months and years. Hence contaminated intermediate objects may serve as fomites.

5. *Portal of Entrance.*—By inoculation of the spores into the subcutaneous tissues by scratches, wounds or the inhalation of spores in dust.

6. *Incubation Period.*—Within seven days.

7. *Period of Communicability.*—During the febrile stage and until the lesions have ceased discharging. Infected hair and hides of infected animals may communicate the disease for many months after the slaughter or skinning of the animals, and even after the curing of the hide or hair, unless previously disinfected.

8. Methods of Control. *The Infected Individual.*—(*a*) Diagnosis: Clinical manifestations confirmed by bacteriological examination.

(*b*) Isolation: Until the lesions have healed.

(*c*) Immunization: No highly effective method for the immunization of man has been developed. The anti-anthrax serum is well worth a trial. Normal beef serum is said to give good results.

(*d*) Quarantine: None.

(*e*) Concurrent Disinfection: Of the discharges from the lesions and of objects soiled therewith.

(*f*) Terminal Disinfection: Thorough cleaning.

General Measures.—(*a*) Animals ill with a disease presumably anthrax should be placed immediately in the care of a veterinarian. Proved cases should be promptly killed and the carcass destroyed by cremation.

(*b*) Isolation: Only of suspected cases.

(*c*) Active Immunization: Of exposed animals under governmental supervision. The double vaccine, consisting of two separate inoculations with doses of graded virulence, is in most general use.

(*d*) Post mortem examinations should be made only by a veterinarian or bacteriologist.

(*e*) Milk from an infected animal should not be used.

(*f*) Control of and the disinfection of sewage effluents and trade wastes from factories and premises where spore infected hides or hair are known to have been worked up into manufactured articles.

(*g*) A physician should be employed by every company handling raw hides or hair, or else such companies should operate

FIG. 93.—Wool sorting. In wool manufacturing centers occupational anthrax is commonly known as "wool-sorters' disease." (*Bull.* 205, *Bur. Lab. Stat.*)

under the direct supervision of a medical representative of the health department.

(*h*) Every employee handling raw hides, hair or bristles who has an abrasion of the skin should immediately report to a physician.

(*i*) All employees in such establishments should be personally instructed in the necessity for personal cleanliness.

(*j*) Tanneries and woolen mills should be provided with proper ventilating apparatus so that dust can be promptly removed.

(*k*) All hair, wool, and bristles originating in known infected

centers should be disinfected before they are cured or sorted (Fig. 93).

(*l*) The sale of hides from animals dying from anthrax should be prohibited.

(*m*) Hides of unknown origin should be disinfected. Means of disinfection that will not interfere with the desirable properties of leather are not available. The following is the least objectionable method:

Immerse the hides in 1 per cent. hydrochloric acid and 8 per cent. sodium chloride for 6 hours at a temperature of 40°C. Then neutralize with sodium carbonate and wash.

(*n*) Workmen should be instructed to avoid touching blood clots on hides or hair.

TETANUS

1. *Infective Agent.—Bacillus tetani.*

2. *Source of Infection.*—Herbivorous animals, particularly horses and mules.

3. *Portals of Exit.*—The feces of such animals, rarely the discharge from infected wounds.

4. *Route of Transmission.*—Animal manure and objects and soil contaminated with animal manure. The spores of the organisms are very resistant and can survive for indefinite periods outside the body. Hence fomites transmission occurs.

5. *Portal of Entrance.*—Subcutaneous introduction of spores into wounds, cuts and abrasions, usually through their contamination with soil or manure, hair, etc.

6. *Incubation Period.*—Six to fourteen days, usually nine.

7. *Period of Communicability.*—The patient is not a source of infection, except in rare cases where the wound discharges are infective. On the other hand, some horses are chronic carriers.

8. Methods of Control. *The Infected Individual.*—(*a*) Diagnosis: Clinical manifestations which may sometimes be confirmed bacteriologically.

(*b*) Isolation: None.

(*c*) Immunization: Passive protection, secured by the administration of antitoxin, should be employed. The antitoxin has given the best results as a prophylactic agent. As a result of recent military experience the folllwing rules should be followed in its administration:

1. Every wounded person should receive at least 500 units

prophylactically. This dose should be repeated on the 7th and 14th days thereafter.

2. Repeat the doses at more frequent intervals if there is any reason to fear tetanus.

3. Repeat injections forty eight hours prior to any secondary operation.

4. If tetanic manifestations develope, the subcutaneous and intramuscular routes of injection are preferable. Daily doses of at least 10,000 units should be given and continued well into convalescence. The injections should be given at different depths and at several points in the muscle tissue on the injured side, if an operation is contemplated.

The importance of early prophylactic doses is indicated by the following results in 65 cases of tetanus:

(*a*) Antitoxin administered within 24 hrs. of wounding: 43 cases, each receiving 500 units; 62.7 per cent. fatal, 37.2 per cent. recovered.

(*b*) Antitoxin administered after 24 hrs. of wounding: 23 cases, each receiving 500 units; 86.9 per cent. fatal, 13.1 per cent. recovered.

(*d*) Quarantine: None.

(*e*) Concurrent Disinfection: None.

(*f*) Terminal Disinfection: None.

General Measures (*Especially to Prevent Wound Contamination*). (*a*) Supervision of the practice of obstetrics, so that proper care is given to the care of the infant's cord (Trismus neonatorum).

(*b*) Educational propaganda, along the lines of the "safety first" campaigns and "Safe and Sane" Fourth of July campaigns.

(*c*) Prophylactic use of tetanus antitoxin when wounds have been acquired in regions where the soil is known to be heavily contaminated with manure, and in all cases whose wounds are ragged and penetrating.

(*d*) Removal of all foreign matter from wounds as early as possible.

(*e*) Governmental supervision of biological products, so that only potent antitoxin is distributed.

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CHAPTER XXIII

OTHER ASPECTS OF INFECTIOUS DISEASE

1. In the foregoing chapters we have considered a number of the infectious diseases of public health importance in the United States. These for the most part are diseases which are systemic in character and the losses we have considered have been direct losses either from sickness or death. There is another type of damage which these diseases may produce that is fully as important as the losses we have heretofore considered, namely the sequelæ. These consist of a permanent injury or impairment of function arising from the illness, as a consequence of which the individual may never be restored to the degree of physical efficiency existing before the illness, and while he may recover from the infection, the permanent damage may either assist in the development of other pathological processes which shorten life or reduce the economic efficiency of the individual. We will briefly consider the injuries of this character. But little quantitative data on this point are available, so the presentation will deal necessarily with generalities.

In a study of nearly two thousand cases of typhoid fever, Dublin finds that cardiac disease and a lowered resistance to tuberculosis are the most important sequelæ manifesting their effect within three years following recovery. He concludes that during this period the mortality is twice that among individuals who have not had typhoid fever. It is usually considered that with typhoid, ten per cent. of the cases have a fatal outcome. He points out that in addition, the sequelæ which produce a fatal outcome increase this mortality very nearly by five per cent. The fact that an increased mortality from tuberculosis is observed is very important. Many of the acute infections so undermine the individual's resistance to a more chronic infection such as tuberculosis, to an extent that a heretofore latent infection becomes active or the nephritis appearing as a complication of scarlet fever may fail to clear up with convalescence, and remain as a permanent injury to the individual. Diphtheria toxin may permanently impair the

nervous system, so that the post-diphtheritic paralyses are one of the most dreaded sequelæ of any disease. Likewise the great popular horror of poliomyelitis arises from the disabling paralysis so common in those who recover. The greatest progress we have made with poliomyelitis in recent years has been in the intelligent orthopedic handling of these cases. The results are so striking and so beneficial that many progressive state health authorities are now following up all poliomyelitis cases and making provision for orthopedic relief. Similar disablement may follow cerebrospinal meningitis, together with deafness. Noticeable mental or nervous impairment may follow typhus fever or whooping cough. Gonorrheal infection of the genitalia in either male or female is frequently responsible for subsequent sterility of the individuals, and where infection is transferred to the eye, permanent blindness may result. After the active infective stages of syphilis are past the individual may suffer great physical disability from the lesions of the tertiary and quaternary stages. It is therefore apparent that the ravages of those diseases are not sufficiently brought out by a study of the mortality or morbidity records alone.

Another aspect of this subject is that of the so-called "focal infections" whose importance was first emphasized by Billings and his associates. Chronic infection localized in some obscure area of the body may be responsible for the production of acute rheumatism, chronic deforming arthritis, gonorrheal arthritis, malignant endocarditis, myositis, myocarditis, septicemias of several types, certain infectious types of thyroiditis with or without hyperthyroidism, acute and chronic pancreatitis with or without glycosuria, gastric ulcer and cholecystitis. The situations in which the chronic infection is localized are most commonly the dental alveoli, the tonsils, the gall bladder, the appendix or a nasal sinus. From these locations bacterial emboli are thrown off into the circulation, and if the defenses of the body are diminished by overwork, exposure to cold, dissipation, insufficient or improper food, unhygienic surroundings, injuries from former diseases (valvular scars) or trauma, some of the conditions mentioned may develop. The responsible micro-organisms are most commonly those of the pneumococcus-streptococcus group. From a public health standpoint these conditions do not come to the attention of the health authorities except in so far as they participate in mortality production. But from the standpoint of the practising physician they are a field of preventive medicine in which brilliant results may be

secured by searching for the chronic focus of infection and effecting its removal.

Disease prevention by the developement of an active artificial immunization against the infective agent concerned, among all susceptibles in a given population, is our chief weapon in the control of certain infections such as smallpox, and a valuable adjunct in others. The maximum efficiency of such measures is only achieved where immunization is made compulsory and where furthermore, the requirement is enforced, so that a large part if not all the people are protected Unfortunately in civil life, compulsory vaccination has lead to a greater or less amount of opposition among a few bigoted persons who fortify their position by refering to the very small number of accidents and secondary infections following the practice, and ignore the achievements in disease reduction that has followed the extensive employment of the method. This opposition in some localities has been so vigorous that authorities have been unable to enforce the provisions of laws requiring compulsory vaccination while in others the authorities are forced into a continuous fight to prevent the repeal of the statutory requirements. In many localities the situation is discouraging. Fortunately the situation has a redeeming feature. Those who receive immunization receive protection, while those who do not, either through ignorance, carelessness or opposition run the far greater hazard of the virulent infection. Those who remain unvaccinated through opposition are sufficiently punished if they contact infection. Health authorities can in a large measure protect the individuals of the other groups by education of the public in the advantages of vaccination, by the distribution of free vaccine, and by providing for its free administration. Sufficient activity along these lines may very nearly achieve the same results as compulsory methods, without arousing hampering opposition. Practicing physicians can do a great deal in disease prevention by actively immunizing their clientel.

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SECTION II

DEFICIENCY DISEASES

CHAPTER XXIV

FOOD REQUIREMENTS: PRODUCTION AND RETAIL

1. The activities of the cellular tissues of the body require that the necessary material for growth, for renewal of the worn tissues and for energy be supplied. This material constitutes food. From it the body liberates the necessary energy and secures new material for replacement purposes. Cellular activity is in different directions and for each type of activity different raw materials must be furnished. The most important raw materials which the body requires are protein food and certain mineral salts. The importance of protein arises from its nitrogenous content and hence it serves chiefly in repair and new growth, and to a lesser extent as a source of energy. The energy requirements are chiefly met by carbonaceous foods. The mineral salts are required to maintain tonicity of the body fluids, to build up the solid tissues, to form hemoglobin and for other purposes.

The determination of the value of any given substance as a food is not a simple matter. Several different aspects must be considered. First perhaps, must be considered the percentage chemical composition of the substance. It must be assayed to determine its value in terms of food constituents, such as protein, carbohydrates, fats and inert material. A second test to determine suitability is of a physical character, and enables us to judge the value of the food stuff as a fuel or source of energy. It is usually calculated from the results of the chemical analysis by the employment of the following factors, and is expressed in calories:

1 gm. of protein will produce...........	4.1 calories
1 gm. of carbohydrate will produce	4.1 calories
1 gm. of fat will produce...............	9.3 calories

However, since different food stuffs are not consumed in the body to the same degree, those factors will not always give an accurate idea of the value of a food as fuel. Next one must consider the food stuff from the body's standpoint. It must be one which is capable of digestion and absorption by the body, and of meeting the body's needs. Different individuals are capable of utilizing different materials to different degrees. In general 92.6 per cent. of protein; 94.4 per cent. of carbohydrate and 97 per cent. of fat are absorbed. Some few, such as sugar are practically entirely absorbed. A fourth and equally as important guide to judgment is the knowledge whether a given food stuff can be obtained at a reasonable cost.

In general the following represents what may be considered a standard in the United States for the proportion in which the different food elements should be represented in the diet of adults each day.

Protein..........	125 gms. × 4.1 =	512.5 calories
Carbohydrates....	400 gms. × 4.1 =	1640. calories
Fat.............	125 gms. × 9.3 =	1161.5 calories

Some variation in these proportions can be made without injury but a certain amount of protein is absolutely necessary, though the exact limit is not known. A further important factor in considering the protein element is whether its content of amino acids is of the one or more types which the body can rebuild into its own protein. If the amino acids are unsuitable, the protein present is useless.

Of the food consumed, less than one-sixth furnishes energy for work, the balance being lost as heat. In this respect the body's requirements and use of food are similar to the fuel consumption of an engine. Similarly more work requires more food. An average adult male of 150 pounds weight engaged different activities has approximately the following daily fuel requirements:

Resting in bed....................	2000 calories
Resting in a chair................	2230 calories
Light work......................	2600 calories
Moderate muscular work.........	3100 calories
Severe muscular work............	3500 calories

The energy for the extra work is chiefly supplied by the carbonaceous foods.

2. Food is essential to life and because of this requirement,

food production everywhere is a fundamental industry and is the principal basis of agricultural pursuits. From the standpoint of raw materials or source, food stuffs are either animal or vegetable in origin. From a hygienic standpoint, the animal foods are of greater importance than the vegetable, as has been shown in Chapter XIX. With the animal foods we can group meat, fowl, fish, shellfish, crustaceans, insects and their products, eggs, milk and dairy products, animal fats and gelatine. The vegetable foods comprise cereals, vegetables proper, fruits, sugar, gums, vegetable oils and fats. While the production of these food stuffs is the basis of agriculture and fishing pursuits, yet many as produced are not suitable for immediate use as food, or if suitable they require treatment to remove bulky, inert, and useless material, or to preserve them suitably for transportation. Around these processes have grown up a host of secondary industries. It is apparent therefore that industries based upon food stuffs are at the foundation of our economic life, as the need for food is at the foundation of our physical life.

3. In connection with the handling of food stuffs, and the development of various technical processes in their treatment, certain practices arose, many of which were fraudulent in character and a few perhaps inimical to health, which the Federal and State governments have endeavored to suppress by means of the so-called Pure Food Legislation. These objectionable practises are commonly known as adulterations and according to most legislation are classified as follows:

(*a*) Mixing the material with foreign substances to reduce or lower, or injuriously affect the quality or strength, as for example the mixing of water with milk.

(*b*) The substitution of one substance for another, either wholly or in part, such as the employment of cotton seed oil for olive oil.

(*c*) The removal of any valuable constituent either wholly or in part, as for example the skimming of cream from milk.

(*d*) The treatment of the food stuff to conceal damage or inferiority, as for example the addition of sulphites to old meat to give it a bright red color.

(*e*) The presence of added deleterious ingredients, injurious to health. The so-called chemical preservatives come under this head, such as borax or formalin.

(*f*) Or the retail of food stuffs that are wholly or in part decomposed, filthy, or putrid.

It can readily be seen that for the most part the practices grouped here deal practically with the cheating of the purchaser or consumer by unscrupulous dealers, and as such more directly affect the pocket book than it does health.

4. Most food stuffs are as well adapted to the needs of various other forms of life as they are to man's, particularly to micro-organisms. As a consequence of the activity of these, most food stuffs readily spoil or undergo decomposition. One of the greatest forward steps in our economic progress has been the discovery and application of means whereby decomposition may be prevented. Thus seasonable and perishable foods may be kept from years of plenty to years of scarcity, perishable foods may be transported to distant markets, and dense concentrations of population at a great distance from their source of food supply are possible. The great cities of our day have developed progressively with the development of food preservation.

The object of food preservation is to preserve the nutritive value of the food stuffs and their palatability for an indefinite period and at least until the next season. Food stuffs designed for preservation should be fresh and wholesome in their raw state. The methods of preservation are all designed to inhibit the activity of the micro-organisms which produce the changes of decomposition. Among these we may mention refrigeration and freezing, drying, salting, smoking, canning by the aid of heat (sterilization), preserving by the use of strong sugar solutions, and the use of antiseptic chemicals, such as vinegar and spices.

5. Of equal if not of greater importance with production from a hygienic aspect, are the conditions of retail sale and consumption of food stuffs, particularly from the standpoint of the transmission of infective agents. Food stuffs on the retail market are as a rule but a few hours away from their consumption, so that if contaminated with infective agents the chances for the survival of the latter and their successful invasion of the consumer are excellent. From an esthetic standpoint, the physical appearance of a retailer's wares influences the purchases a customer will make. The two conditions we have mentioned are affected by the character of the retail establishment, its cleanliness, the number and variety of vermin present and whether food stuffs are protected from vermin as well as unnecessary handling by both clerks and prospective customers. And in this connection restaurants are of equal if not greater

importance than retail stores. Clerks, waiters, cooks, dish-washers, etc., may be typhoid carriers or in the active infective stage of venereal disease or other infection; or the knives, forks, spoons, plates, cups, etc. of eating houses may not be adequately cleansed between the services they render to successive patrons, so that infective agents survive upon them. In this capacity soft drink stands are of great importance. The ordinary methods of washing dishes, glassware and eating utensils employed in restaurants and eating houses are insufficient to destroy infective agents present in the buccal secretions with which they are contaminated after use. Furthermore

FIG. 94.—Dish-washing—a simple, efficient method of sterilizing the dishes (*Overton and Denno, "The Health Officer."*)

they serve to distribute these over all other dishes which are being washed at the same time. The use of boiling water is the most practical method for effecting this sterilization. The dishes, etc., are given a preliminary cleaning in hot water supplemented with soap, or in soap suds, and then placed in a wire basket, which is dipped into a large kettle of boiling water kept constantly available for this purpose. This method of handling dishes possesses the additional advantage that no subsequent wiping is necessary. Or in the retail stores, foodstuffs many of which are ordinarily eaten without further heating or cooking, are exposed to flies, roaches, rats, mice,

dogs, or the fingers of prospective customers. Thus their contamination with infective secretions may occur and infective agents upon them stand an excellent chance of reaching a new host. Employees who have cases of diseases transmitted by contact in their families should be excluded from employment until it is ascertained they are free from infection and that they subsequently remain away from their infected household during its quarantine.

CHAPTER XXV

DISEASES DUE TO DIETARY DEFICIENCIES

RELATION OF FOOD TO HEALTH

The quantity of food required to maintain the body in vigor varies with the climate and season, clothing, occupation, work and exercise, the state of individual health, age, sex, and body weight. Modern conditions of food preparation frequently stimulate the appetite so that one consumes food far in excess of the body's requirements. When coupled with insufficient exercise the results are bad. When prolonged it may lead to such diatheses as obesity and gout, and even though these conditions may not be produced, the temporary effects, the congestion of the digestive tract, the intestinal stasis, all exert a reflex action upon the central nervous system with the production of headache, mental fatigue and lassitude. Conversely the lack of sufficient food is also deleterious. In the complete absence of food life can rarely be sustained over ten days. An insufficient diet has another important effect. Individuals who are poorly nourished have their resistive forces lowered to such an extent that they fall a ready prey to invasions by micro-organisms and the probabilities of a fatal termination are also much greater. This is illustrated by the severe epidemics which have so frequently been associated with famine.

Associated with the question of an insufficient diet is the question of an unbalanced diet, by which we mean one in which the proper proportion of protein, carbohydrate and fat are not represented. Economically the parallelism of poverty and want in connection with these is sometimes very close, though we also see an unbalanced diet resulting from a perversion of appetite or inability, from other circumstances, to secure the necessary materials. Thus an anemia may be due to lack of meat, an excess of carbohydrates and fats may produce acne and eczema or an excessive concentration may produce constipation. In addition diseases such as pellagra and beriberi appear to owe their origin to an unbalanced dietary. We shall discuss these briefly later.

Substances consumed as food may exert directly a toxic or

injurious action on the body in various ways. Thus ignorant people may undertake to use naturally poisonous substances as food and suffer severely as a consequence, employing for example, toadstools, certain poisonous fish or plants containing toxic alkaloids. Through accidents in preparation or for commercial reasons, extraneous poisonous substances may be present in toxic amounts, such as the heavy metals, arsenic or formaldehyde. Or the food stuffs, while normally wholesome and harmless, may through some natural change become toxic, as for example the development of solanin in potatoes and of ergot in rye. Some will consume excessive quantities of alcoholic beverages, such as beer, wines or whisky, etc. Or lastly some individuals have iodiosyncrasies toward certain foodstuffs. The manifestations of these idiosyncrasies very much resemble an anaphylactic reaction. Among the foodstuffs for which these reactions have been noted, are strawberries, certain sea foods, eggs, oatmeal and tomatoes.

There are three deficiency diseases whose common character warrants their receiving especial attention, namely scurvy, beriberi and pellagra.

SCURVY, BERIBERI, AND PELLAGRA

Definitions.—(*a*) Scurvy is an acute or chronic disease characterized by debility, mental apathy and anemia, with sponginess of the gums and ulcerations of the mouth, manifesting a tendency to hemorrhages into the subcutaneous tissues and from the mucous surface.

(*b*) Beriberi is an acute or chronic disease characterized by changes in the nervous system, and particularly by a multiple peripheral neuritis, with an especial tendency to attack the nerves of the limbs, the pneumogastrics and the phrenics, with varying degrees of cardiac disturbances, œdema, serous effusions and gastro-intestinal derangements.

(*c*) Pellagra is an acute or chronic disease characterized by a peculiar erythema and dermatitis on those parts of the body exposed to the sun's rays, by salivation, dyspepsia, and diarrhoea, and by nervous manifestations which may terminate in mental disturbances and paralysis.

Geographic Distribution.—In general one may say that they are world wide, though varying in their relative prevalence, as shown in the following table which indicates their greatest incidence.

Scurvy	Beriberi	Pellagra
Has prevailed in all European countries, Southern Asia, Australia, South Africa and Egypt and the United States.	Common throughout the Orient, especially in China, Japan, the Philiippines, India, Africa and South America. Rare in the United States.	Southern Europe, Italy, Spain, Orient, and the Southern United States.

Incidence.—They may occur either as sporadic cases or in a wholesale prevalence simulating epidemic or endemic distribution. Such latter instances usually occur among closely circumscribed groups of people, such as soldiers at military posts or on campaigns, laborers at labor camps, exploring parties, sailors on long cruises, inmates of jails, penitentaries, insane hospitals and other similar institutions.

Past Ideas of Etiology.—Widely different theories of their etiology have been held until recently and these we shall briefly review before passing to current knowledge.

(*a*) Scurvy has been variously ascribed to : (1) a deficiency of potassium in the blood; (2) a decreased alkalinity of the blood, *i.e.*, an acidosis; (3) to ptomaine poisoning; and (4) to a specific infection.

(*b*) Beriberi has been ascribed to; (1) poisoning by arsenic or by oxalates; (2) to a deficiency of nitrogen, fat or phosphorous; (3) a specific infection; or (4) as an unknown intoxication.

(*c*) Pellagra has been variously regarded as: (1) an intoxication due to the consumption of spoiled corn; (2) as a specific infection, either transmitted by contact or by the agency of the small black flies of the genus *Simulium*; or as an intoxication due to colloidal silica.

Some few perhaps still adhere to some of the foregoing views, but in general we believe that the majority of scientific men regard these diseases as having the following etiology.

Present Views of Etiology.—(*a*) Scurvy (Holst and Frölich) is found to be due to a deficiency of some essential constituent from preserved foods but which is present in all kinds of fresh food, both animal and vegetable.

(*b*) Beriberi (Fraser and Stanton, Vedder, et al) is due to the removal in the process of milling and polishing rice or wheat, of certain substances present in the pericarp of the grain, which are necessary to life (Figs. 95, 96, 97, 98). About 1 gm. of

this substance is present in one kilogram of rice and it may be extracted from rice millings by alcohol. By its employment dry beriberi and experimental polyneuritis of fowls may be cured.

(*c*) Pellagra (Goldberger and Wheeler) is due to a diet devoid of meats or vegetable fats. It has been produced in 6 of 11

FIG. 95.

FIG. 96.

FIG. 97.

FIG. 98.

FIG. 95.—A highly milled or polished rice stained by Gram's iodine solution. The starch, being completely exposed, stains uniformly a dark blue. This rice will produce beriberi.

FIG. 96.—An undermilled rice stained in the same way. The unstained areas show where the adherent pericarp has protected the starch from the action of the iodine. This rice will probably not produce beriberi.

FIG. 97.—A sample of undermilled rice that contains still more pericarp. The use of this rice will surely prevent the development of beriberi.

FIG. 98.—The unhusked groid or "palay." When the husks are removed by hand pounding, a rice like Fig. 97 or Fig. 96 is produced. (*From Vedder, "Beriberi," Wm. Wood and Co., Publishers.*)

convicts by a five months diet of biscuits, cornbread, collards, grits, rice, fried mush, brown gravy, sweet potatoes, cabbage and cane syrup. Some are inclined to dispute the correctness of the diagnosis of pellagra among the subjects in this experiment.

Vitamins or Accessory Food Factors.—Based upon the discovery of the therapeutic value of rice milling extracts in the cure of beriberi, these diseases have been ascribed to the absence of minute quantities of certain substances from the diet. Recent researches by Funk, McCallum and others have so far resulted in the recognition of two of these substances in foodstuffs, one of which is soluble in water, the other in fats. Their chemical nature is unknown. These are also designated factors B and A respectively. The beriberi vitamin or antineuritic factor is identified with the water soluble factor B. Both of these are experimentally found to be essential for growth and maintenance. From the known relationship of scurvy to preserved foods, a third vitamin, an antiscorbutic factor, is assumed to exist in fresh vegetable food. To fat soluble A are attributed antirachitic properties. Thus in addition to possessing a knowledge of the protein, carbohydrate and fat content of a dietary, it is also necessary to consider its content of vitamines or accessory food factors. The utilization of these substances in the body is not certainly known, but Green considers their main functions concern the gross metabolism of food, probably principally in oxidative catabolism.

The water soluble B is chiefly secured from grain (germ and pericarp), eggs, yeast and legumes (entire seed). The fat soluble A is chiefly secured in cream, butter, cod liver oil, egg yolk and green legumes. The antiscorbutic factor is chiefly found in cabbage, turnips, lettuce, cresses, tomatoes, oranges and citrus fruits, and to a lesser extent in potatoes and carrots. It is destroyed in any dried food. In general the vitamins are destroyed or lost by cooking, by overheating (milk), by laking out in boiling, by too prolonged desiccation or by discarding the outer covering of grains.

The Individual Prevention and Cure of these Diseases.—

(*a*) Scurvy: Among these groups where scurvy has appeared the disease has disappeared following the addition of either: (1) juice of fresh sweet limes or lemons; (2) infusions of malt, (3) sauerkraut, (4) milk or (5) fresh potatoes to the dietary.

(*b*) Beriberi too has disappearaed or has not developed with diets having the following characteristics: reduction of the amount of rice or a substitution of unmilled for polished rice, and the addition of legumes and other vegetables.

(*c*) According to Goldberger by increasing the amount of fresh animal food and legumes in the diet of the inmates of three institutions where pellagra has been prevalent, he has

prevented its recurrance during a period of one year, even among those individuals who were pellagrins during previous years.

Public Protection.—The problem of dealing with these diseases from a public standpoint is more difficult of attack than is the administrative control of communicable diseases, and probably is more dependent upon popular education.

(*a*) Beriberi can probably be publically controlled by placing a prohibitive tax on the sale of polished rice.

(*b*) Pellagra on the other hand, is more difficult. An increased consumption of milk, eggs, legumes and fresh vegetables, together with meats is necessary. To a large extent this requires an improvement in the economic condition of the wage earners to enable them to increase their living standards. Some of this can be accomplished by domestic gardening and chicken raising.

ALCOHOLISM

Thanks to national prohibition this disease will soon be a matter of historical interest in the United States. The consumption of alcoholic beverages for their stimulating effect is a world wide habit of long antiquity. The evils it produces are both directly and indirectly due to its agency, and are both hygienic and economic. The latter is outside our province to discuss. As a contributing factor it is of wide spread importance in commercial prostitution and hence is an important factor in the dissemination of venereal diseases. The elimination of alcohol will go far to reduce commercial prostitution and hence reduce the extent to which venereal diseases are transmitted. Directly it is chiefly of importance as a cause of mental disturbances or psychoses. It is the direct cause of Korsakoff's psychosis, alcoholic hallucinations, delerium tremens and alcoholic deterioration. It is a contributory cause to others. This group of psychoses are responsible for about twelve per cent. of all first admissions to hospitals for the insane, and in general are more common in males than females, and in those from cities as compared with rural inhabitants. It is uncertain whether alcoholism is a factor in the hereditary transmission of mental deficiency.

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SECTION III

OCCUPATIONAL DISEASES

CHAPTER XXVI

HAZARDS OF OCCUPATION

In the pursuit of a livelihood wage earners are exposed to varying risks and hazards, some of which are peculiar to their occupation while others arise as a result of their own or some one else's carelessness. We shall consider briefly the more important of these.

1. From the standpoint of the number and gravity of the hazards encountered the principal occupations of mankind may be grouped as follows:

Occupational class	Character of hazards
A. Manufacturing and Mechanical **Industries**	(*a*) Unsanitary home environment. (*b*) Employment in unhygienic surroundings. (*c*) Inadequate lighting and ventilation. (*d*) Inadequate toilet facilities. (*e*) Infection. (*f*) Dust, fumes and poisons. (*g* Unguarded, carelessy operated, or defective machinery. (*h*) Fire hazards, increased air pressure.
B. Transportation (railroad men and sailors).	(*a*) Same as above.
C. Construction Work.	(*a*) Same as above.
D. Mining and the extraction of minerals.	*a*) Unsanitary home environment. (*b*) Premature explosions. (*c*) Fire damp, fires and dust. *d*) Unguarded and defective machinery. (*e*) Fall of roof. (*f*) Poisons. (g) Underground work, excessive heat or moisture.

E. Agriculture, forestry and animal husbandry.	(*a*) Unsanitary home environment.
	(*b*) Accidents from machinery and timber.
	(*c*) Infection from livestock.
F. Mercantile and Clerical Pursuits.	(a) Defective hygienic conditions.
	(*b*) Inactivity, fatigue.
G. Individual service, public, professional and domestic	(*a*) No distinctive hazards.

From the foregoing it can be seen that different occupations vary in the number and variety of hazards encountered, some are common to many, others are peculiar to a group. We shall next consider the principal individual hazards, their danger and the means of their amelioration.

2. Unsanitary Home Environment.—The development of manufacturing industries, mines, or construction enterprises is frequently in situations inconveniently distant from previously existing cities or towns, or the number of workmen required for the enterprise is far greater than the number of vacant homes available. For this reason large companies have frequently built residence towns or additions to existing towns to accommodate their employees. Many of these towns and the dwellings which comprise them have been constructed with very little thought to the welfare of those who must occupy them. The houses may be illy lighted or ventilated, water supply and excreta disposal are inadequate, mosquito breeding is permitted and gross overcrowding may prevail. On the other hand many enlightened corporations have constructed towns of model dwellings.

Some rural or agricultural homes are fully as bad or even worse than those in the slum districts of large cities.

3. Inadequate Ventilation.—Many industrial processes give rise to dust and fumes, some of which are poisonous. In the vicinity of furnaces and open flames the oxygen content of the air is frequently much below normal, and the air may also be very smoky. Under these conditions the air is certain to be very hot, or under other conditions may be excessively humid as well. For this condition exhaust ventilation is the best remedy, with the exhaust intakes placed close to the situations where dust or fumes are produced.

4. Inadequate Lighting.—Natural illumination is frequently insufficient. Artificial illumination is likewise frequently in-

sufficient or improperly employed, so that the work is poorly illuminated or the light shines in the workmen's eyes. Where a blinding illumination must be tolerated goggles are necessary.

5. **Excessive Heat.**—The bad effects of excessive heat may be counterbalanced by the use of goggles, body shields, air blasts, fans and water sprays. The workmen exposed to excessive heat should have a short work day, and shower baths should be available for their use when leaving work.

6. **Fatigue and Inactivity.**—Fatigue is the chief cause of accidents from carelessness and furthermore decreases production. It arises from laborious work, long hours, piece work, speeding up practices, monotony, constant standing or a constant strained position, the use of chairs or stools without backs, faulty postures, jarring operations, the pressing or holding of objects against the body, eyestrain, loud noises, irregular hours of sleep and the absence of work variation or periods of relaxation. Similarly the inactivity of the sedentary worker induces fatigue. It is one of the most important problems in industrial hygiene.

7. **Extremes of Humidity.**—Sedentary work should not be done in a humid atmosphere. If the air be excessively dry, provision should be made for its humidification.

8. **Dust** affects the lungs, the skin, the eyes and the external auditory canal. Protection from it may be secured by the use of goggles, respirators, wet processes, exhaust ventilation and the avoidance of dry sweeping. Of the different dusts encountered in industries, soil dust is the least harmful, then in order of increasing danger come flour and starch, soapstone and talc, wood dust, bran dust, coal dust, clay dust, shell dust, ore dust, mineral dust and stone dust. These dusts may be either poisonous or irritating. The latter have an important relationship to industrial tuberculosis. The problem of dust will be considered later in more detail.

9. **Poisons** are encountered in industry as either fumes, gases, solutions, pastes or solids. The list includes lead, benzine, benzol, turpentine, brass or zinc fumes, acids, alkalies, wood alcohol, anilin oil, carbon bisulphid, antimony, illuminating and fuel gas, hydrogen sulphide, arsenic, phosphorous, mercury and cyanide. Industrial poisonings usually occur because the amount of risk is not appreciated either by the employees or the employer. In combating their danger it is frequently necessary to overcome the following handicaps: (1) an employer's policy of keeping the employees in ignorance of the poisons used;

(2) misbranding of poisonous substances; (3) lack of instructions or, (4) disregard of instructions; (5) absence of mechanical health appliances, such as adequate ventilation; (6) permitting employees to eat while at work or in the work rooms; (7) lack of personal cleanliness among employees; (8) lack of sufficient washing facilities; (9) absence of gloves and respirators; and (10) no change of clothing on leaving work. Each poison presents a different problem. These also will later receive more detailed consideration.

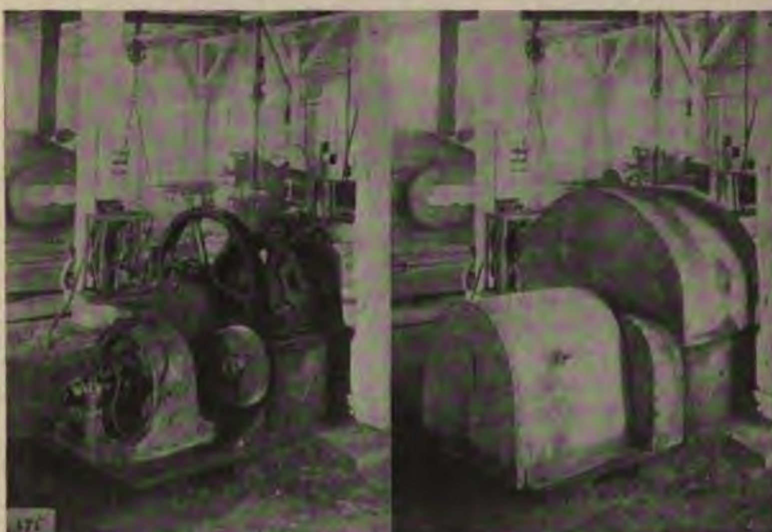

FIG. 99.—Rotary shears before and after protecting. Notice—"Stop this machine when oiling, wiping or repairing." Tennessee Coal, Iron and Railroad Company. (*Bull.* 4, *U. S. Steel Corp.*)

10. Infections.—Infections may be contracted either from other workmen by the agencies of contact, or from the material handled. Wounds received while at work and improperly cared for may become seriously infected. Contact transmission is favored by overcrowding, by the use of common towels and drinking cups, absence of cuspidors and consequent spitting on the floors, by sweeping during working hours, and by mouthing objects handled by another. Agriculturists may become infected from sick livestock, while workers in hair and wool may become infected with anthrax from this material. A certain degree of protection is afforded by first aid training, but

still better in a manufacturing plant is a surgical emergency room with a trained nurse in charge, and a supervising surgeon.

11. Unguarded or Defective Machinery.—This is one of the most potent sources of danger. The following moving parts of machinery should be protected by suitable guards so that hair, clothing, or the fingers may not be caught or the person crushed or mangled, viz.: gears, rolls (Fig. 99), belting, rope or chain drives, all horizontal belts or shafting less than seven feet from the floor, beltshifts or loose pulleys, clutches, shaft guards and set screws. Fly wheels and emery wheels should also be guarded, and the latter should be suitably connected

FIG. 100.—Concentrating plant Oliver Iron Mining Co. 32,000 feet of pipe for hand and guard rails were used in connection with platforms at this plant, giving safe access to all machinery. Guarded plattorms. (*Bull.* 4, *U. S. Steel Corp.*)

to an exhaust vent. Additional points for safety in factories are the following: (1) Glass panels on swinging doors in passageways, (2) ladders should have sharp points on their feet, (3) elevated platforms around machinery should be railed (Fig. 100), (4) saws of different types and planes should have suitable guards. Convenient provision should be made for the rapid shutting off of power in the event someone is caught. Similarly power of any sort should not be turned on, or machinery set in motion, unless it is known that no one is in a position to be injured.

12. Transportation Hazards.—Employees suffer from these more than passengers, while trespassers suffer the most. Acci-

dents upon the railroad are mainly due to the following: Carelessness, lack of discipline, overwork, and the lack of safety devices. Passengers mainly suffer from derailment and collisions while employees suffer from accidents arising in coupling and uncoupling cars, and by falling from cars or engines.

13. **Mining and quarrying** have types of peculiar hazards such as fall of roof and explosions. The former can largely be eliminated by proper timbering. Explosions are due to different causes. Float dust containing 10 per cent. or more of volatile matter is very explosive when brought in contact with a naked flame. It should either be wet down or covered with stone dust. Fire damp (CH_4 and O) explodes either from a naked flame or

FIG. 101.—Rescuing fellow-workman. Miners equipped with breathing apparatus. (*Bull.* 4, *U. S. Steel Corp.*)

a shot. Danger from CO in old workings can be readily detected by the use of canary birds (Fig. 102). Many explosions of dust or fire damp are due to the flame produced by explosives. Accordingly the so-called permissible explosive only should be employed. These do not produce a big flame. Miners should not tamp down charges of explosives with metal rods, due to the danger of premature explosions. Charges should be fired from a central switch after all men are checked out from the mine. Fire danger can largely be eliminated by the use of safety lamps and the protection of the shaft (Fig. 101). Additional dangers encountered are from collisions between cars and lack of clearance between the cars and the wall, and also of electrocution from low overhead trolley wires.

14. Air Pressure.—Increased air pressure is only encountered by the "mud hogs" in caissons, in whom rapid decompression may produce the condition known as the "bends." This can be avoided by their gradual decompression in the air locks. (Fig. 103).

15. Fire hazards are numerous and varied. They are affected by the inflammability of the building or of raw materials stored therein. Fire escapes should be adequate for the number of individuals in the building. In this connection we may call attention to the fact that the stair escapes permit more rapid escape from a building than the ladder type. They should preferably be built along a blank wall and connected to

FIG. 102.—The canary is to the mine rescue crew what a thermometer is to the physician. The bird is more susceptible to gas than human beings and when it topples from the perch in its little cage the rescue men know they have gas to reckon with. (*G. H. Taylor: The Survey.*)

windows by platforms. Regular fire drills at unexpected moments will do much to permit an orderly exit when danger threatens. Lack of judgment in the location of the stair wells and elevator shafts frequently does much to spread a fire and prevent the escape of the inmates. If exit doors open outward their jamming by a panic stricken crowd will be largely prevented. Fire risk from inflammable or explosive gases will be much lowered by adequate ventilation. Automatic sprinklers will usually keep blazes from spreading, and extinguish them in their incipiency.

16. Electrical Accidents.—Electric installations offer many opportunities for accidents of a serious character. Danger

signs should be freely employed and dangerous parts of equipment should be painted red. Only experienced and competent

FIG 103.—Air-lock on top of caisson. In sinking foundations for sky scraping buildings men go down beneath the water level and work in compressed-air chambers or caissons. The air pressure is frequently more than three times the normal fifteen pounds per square inch. Workers, if released gradually during decompression in the air-lock avoid the "bends" or compressed-air illness. (*Industrial Dis. Am. Labor Leg. Rev.*, 1912.)

men should be allowed in rooms where dangerous apparatus or wires are installed, and no man should be left alone with a high tension current. Floors that are in dangerous proximity

to wires at high tension should be covered with insulating mats. No repairs of mains or wires, or examinations or alterations should be permitted while they are under a high tension current. Switches should be provided with tell tale lamps, and when a switch is thrown open it should be tagged, and the switch kept open until the completion of the necessary work has been reported. Workmen should take the same precautions with dead apparatus that they do with live apparatus. Rubber gloves should be worn and the sleeves kept down. When working on the primary side of transformers, switchboards etc., only one hand should be used. Plenty of free room should be maintained about the switch boards and their backs should be enclosed. All motors, generators, transformers, etc., should be guarded and also provided with insulated platforms. Terminals, brushes and connections should be so situated that they will not be accidentally touched.

17. The most important factors in the production of industrial accidents are the following:

(*a*) Carelessness.
(*b*) Poor light.
(*c*) Unsuitable clothing.
(*d*) Cluttered up factories.
(*e*) Lack of safeguards.
(*f*) Fatigue, and
(*g*) Overcrowding of the workmen in the shop.

CHAPTER XXVII

OCCUPATIONAL INTOXICATIONS AND DISEASES

Little definite data can be presented concerning the prevalence of occupational diseases, since little attention has been paid them until recent years, and but four states require their reporting. Their frequency as well will be proportional to the prevailing type of economic development. The experience in Ohio will give us perhaps our best guide to their prevalence. Thus recently during a period of seventeen months, there were reported a total of 1204 cases of occupational diseases. The following were the most numerous:

Benzene and benzol poisoning	33 cases
Brass poisoning	124 cases
Lead poisoning	544 cases
Pneumonokoniosis	15 cases

1. Thus we see **lead poisoning** is by far the most important. Its importance is emphasized if we briefly survey the many occupations in which lead is handled and among whose workers lead poisoning may arise. This is presented in the following table, which represents the cases reported above.

TABLE IX.—INDUSTRIES IN WHICH LEAD POISONING MAY OCCUR

Industry	Trade process	No. of cases
Agricultural implements	Painting and bronzing	4
Automobiles and parts	Carpentering on primed work, painting and sanding (Fig. 106)	79
Babbiting metals and solder	Melting	1
Bicycles and sewing machines	Painting and varnishing	2
Brass and bronze products	Founding and soldering	3
Carriages, wagons and parts	Painting and sanding	42
Cars and repairs (R. R.)	Painting, soldering, varnishing	3
Cars and repairs (not R. R.)	Painting and varnishing	6
Cash registers	Tempering	2
Chemicals	Lead burning, ore crushing	6

TABLE IX.—(*Continued*)

Industry	Trade process	No. of cases
Coffins, vaults, etc.	Brass and lead founding, painting, varnishing, buffing and soldering	13
Copper, tin, etc.	Machine shopping, soldering	3
Cutlery and tools	Tempering	7
Electrical apparatus	Lead burning, storage batteries, soldering	107
Enameling and japanning	Enameling	3
Files	File cutting and tempering	3
Flags, regalia, etc.	Painting	1
Foundry and machine shop products	Die casting, founding, painting, soldering	4
Furniture and cabinets	Painting and varnishing	6
Glass manufacture	Lead putty working, mixing ingredients	6
Scientific instruments	Metal grinding, soldering	1
Tin and sheet rolling mills	Tinning	1
Lead bar, pipes, sheets, etc.	Various processes	18
Lead oxides and carbonates	Various processes	36
Oil refining	Handling lead pipes	1
Paint and varnish manufacture	Grinding, mixing, fillng containers, soldering, labelling	25
Painting and varnishing (non mfg.)	House painting	21
Porcelain enameled iron ware	Enameling	4
Pottery	Glazing processes, etc.	61
Printing and publishing	Linotyping (Fig. 104), type setting, etc.	5
Rubber goods	Compounding, mixing, etc.	43
Safes and vaults	Painting and sanding	6
Scales and balances	Painting	7
Ship building	Soldering	1
Signs and adv. novelties	Painting	1
Smelting and refining	Metal refining	4
Stereo and electroplating	Casting	1
Stoves and furnaces	Soldering	3
Wire (works and mills)	Galvanizing, painting, etc.	3
Miscellaneous		1

From the foregoing it can be seen that the industries in which lead products are employed are varied, and that men engaged

in considerably different occupations may suffer from lead poisoning. Painters and those who sandpaper (Figs. 105, 106) painted work, workers in storage batteries, workers in rubber manufacture, printers (Fig. 104) and workers in lead products are the heaviest sufferers. The possibility of lead poisoning must always be borne in mind in the clinical examination of an industrial patient.

2. Channels by which Lead Gains Entrance into the Body.—In most manufacturing processes lead as a poison is encountered

FIG. 104.—Showing installation of exhaust system for linotype machines. Each machine has a molten pot of type metal (lead alloy) from which lead fumes arise. (*Bull. 209, Bur. Labor Stat.*)

in the form of dust, as well as in lead smelting and the manufactures of lead carbonate. Absorption by the lungs appears to be slight, the greater amount of dust gaining entrance by the alimentary canal. Most dust is caught in the nasopharynx and swallowed with the mucous secretions. The dust on entering the stomach reacts with the hydrochloric acid and soluble chlorids are formed which are absorbed. When it reaches the blood it is believed to form a rather insoluble albuminate. If food is eaten at the same time less lead will be converted to

FIG. 105.—Dry sandpapering. Dry sanding of paint is a frequent cause of lead poisoning. The operation fills the air with tiny particles of lead dust. (*Industrial Dis., Am. Labor Legislation Review*, 1912.)

FIG. 106.—Wet sanding with pumice stone. Dust is avoided when sanding is done with wet pumice stone. (*Industrial Dis., Am. Labor Legislation Review*, 1912.)

the chlorid. Lead which is not changed to the chlorid passes out into the feces as the sulphid. Lead carbonate is more soluble in the gastric juices than the sulphate.

In intoxication from lead fumes absorption is by the way of the lungs. It is a less common route than the alimentary, the principle occupations affected by this route being lead smelters and linotype operators. (Fig. 104).

3. **Symptomatology of Lead Poisoning.**—Females and young persons are predisposed to lead poisoning. The onset is very variable, usually manifesting itself in two to four weeks, rarely longer. The onset is more certain and the symptoms more severe when small doses are absorbed over long periods. A gradually developing pallor (anemia) with basophilic stippling of the red cells, a blue line on the gums close to the dental margin, colic and constipation with headache are usually observed. The patient may have convulsions, disturbances of vision or paralysis. Pregnant women always miscarry.

4. **Remedies.**—Efficient exhaust ventilation is essential for the removal of both dust and fumes. The amount of dust produced can frequently be reduced by slight alterations in methods. Provision should be made so that a little food can be kept in the stomach during working hours. Workmen should be instructed to expectorate saliva instead of swallowing it. Adequate washing facilities will assist in removing dust, as will also the requirement that the clothing be changed upon leaving work. In the painting trades much will be accomplished by the substitution where possible of zinc paints for lead paints.

5. **Arsenic.**—Arsenic is chiefly encountered as a dust. Workers in the manufacture of Scheele's Green (a pigment), wall paper, glazed colored paper, artificial flowers, the packing of white arsenic and at works where the ore is reduced, are affected. It acts as an irritant to the skin and mucous surfaces. (Fig. 107, 108).

6. **Mercury.**—A variety of different mercury salts and the metal itself may produce intoxication from the action of either dust or fumes. Thus we find that cinnibar roasters, workers in the extraction of gold and silver, the users of mercury air pumps, barometer or thermometer manufactures, water gilders and felt hat and fur dressers may become intoxicated. Its prevention chiefly requires improvement in ventilating facilities.

7. **Benzin and Benzol.**—These are chiefly used as solvents for quick drying paints and varnishes, for cements and blacking.

FIG. 107.—Arsenic poisoning. Putting Paris green into a bolter. An old and dangerous method. (*Industrial Dis, Am. Labor Leg. Rev.*, 1912)

FIG. 108.—Arsenic poisoning. A comparatively dustless bolter. Respirators worn as an additional protection. (*Industrial Dis., Am. Labor Leg. Rev.*, 1912.)

FIG. 109.—Room at boot and shoe factory. Women and girls are exposed to the fumes of naphtha from open bowls of cement. (*Bull.* 127, *Bur. Labor Stat.*)

FIG. 110.—Casting yellow brass. When the molten metal is poured into the molds, fumes of zinc arise and are precipitated by the cool air of the room into fine gray powdered flakes. In the room shown these are unavoidably inhaled by the workmen, who are thus exposed to the disease known as brass founders' ague. (*Bull.* 127, *Bur. Labor Stat.*)

Those exposed are chiefly cementers in the rubber and boot and shoe industries, as well as dry cleaners and painters. They produce faintness and stupor. Adequate ventilation is required for prevention. (Fig. 109).

8. Zinc Poisoning (Brass Founders Ague).—Brass is an alloy of zinc and copper in varying proportions. When brass is melted a considerable volume of zinc oxide is given off as fumes. (See Fig. 110). Thus brass moulders are chiefly exposed, though brass polishers suffer to a lesser extent. The attacks are acute and come on several hours after exposure. The workmen suffer from rigors followed by a fever, the whole lasting several hours. Chronically it may also produce asthmatic and bronchial symptoms. Efficient exhaust ventilation is required as a remedy.

9. Pneumonokoniosis.—Pneumonokoniosis is a chronic interstitial pneumonia accompanied by a deposit of pigment and usually due to dust encountered under conditions of employment. The physical character of the dust is an important factor in the development of the condition. It affects workers in coal and stone, clay, iron, wool, flour, tobacco, iron oxide, ultramarine blue, hair, cotton, shell, leather and wool.

Dust enters the lungs both by inhalation and the alimentary tract. Inhalation is probably the most important route. The inhaled particles pass to the alveoli despite the obstacles presented by the ciliated epithelium and the minute subdivisions of the bronchioles. They are ingested by the phagocytic epithelial cells which carry them to the connective tissue frame work of the lungs or to the lymphatics, and are later deposited in the bronchial glands. Those which settle in the mouth are enmeshed in the pharyngeal mucus and swallowed. Phagocytes carry them through the intestinal walls to the lymphatics, by which route they are carried to the lungs.

An important related point is the fact that about seventy per cent. of these persons develop pulmonary tuberculosis, doubtless due to the irritation developed. Tuberculosis mortality is about four times as great among workers in dusty trades as in the population as a whole. The harder and sharper the dust the more likely is the condition to develop. It is relatively rare among workers in organic dust, in whom the dust usually sets up a chronic catarrhal condition which only rarely leads to structural changes. Various terms are used to designate this condition when produced by different dusts. Thus in:

(*a*) Coal miners (especially in hard coal) it is known as Anthracosis.
(*b*) Quartz miners (gold) it is known as Silicosis.
(*c*) Stone grinders it is known as Silicosis or Chalcicosis.
(*d*) Pottery workers it is known as Aluminosis.
(*e*) Iron or steel grinders it is known as Siderosis.
(*f*) Tobacco workers it is known as Tobaccosis and
(*g*) Cotton workers it is known as Byssinosis.

The degree to which it developes among workers exposed to hard dust is very high. Ganister disease is a form of silicosis.

FIG. 111.—Grinding iron castings on emery wheels. The dust-removal system shown is effective and protects the workmen to a great extent from flying dust. (*Bull.* 127, *Bur. Labor Stat.*)

The men are engaged in making the brick lining for smelters and retorts. Thus per one thousand men in the ganister trade, 42.3 miners, 179.8 grinders and 22.2 brickmakers die of silicosis. In the zinc mines of Joplin Mo. 66 per cent. of all miners have evidence of pulmonary disease.

The available remedies are based upon dust removal and reduction. Thus exhaust ventilation should be employed where possible and the workmen required to use respirators.

Wetting down of the abrasive work and wet processes should be used where ever possible. (Fig. 111).

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SECTION IV

CHAPTER XXVIII

DISEASES ARISING FROM THE PUERPERAL STATE

In the registration area of the United States, there occurred in 1916, 11,642 deaths during the puerperal state, equivalent to a rate per 100,000 of 16.3. These deaths are classified as follows:

Accidents of pregnancy	985
Puerperal hemorrhage	1118
Other accidents of labor	1212
Puerperal septicemia	4786
Puerperal albuminuria and convulsions	3087
Puerperal phlegmasia, alba dolens, embolus or sudden death	415
Following childbirth (not otherwise defined)	34
Puerperal diseases of the breast	5

During the period from 1901 to 1905 the annual average of the death rate from this group of causes was 14.2 per 100,000, in the next five year period it was 15.5 and during 1913, 15.8; 1914, 15.9; 1915, 15.2. In general it has shown an upward trend. Few classes of death seem more tragic or pitiful than these. We find here the young mother, looking forward with joy to the arrival of her first baby, or the mother of a family of several children, leaving orphans, broken homes, widowed fathers. Probably few deaths leave as great a load of sorrow as do these. It is interesting to compare the losses from these causes with those from some of the other preventable diseases; In 1916 typhoid fever caused 9,510 deaths; measles 7,946, and diphtheria 10,367. If these rates were calculated upon the basis of 100,000 women they would approximately be doubled, and be still higher if calculated in proportion to the women of childbearing age. A still more accurate idea may be secured from the number of maternal deaths per a given number of births. Data on this point can only be given for 1916 and for the birth registration area. The death rate per 1000 live births

from all diseases caused by pregnancy and confinement is 6.5, from puerperal septicemia 2.9, and from all other causes 3.6 (Fig. 112).

Of these deaths the most numerous are from puerperal septicemia. This is important, for of the above causes puerperal septicemia is the least excusable as its preventable character was recognized prior to the bacteriologic era. Holmes first

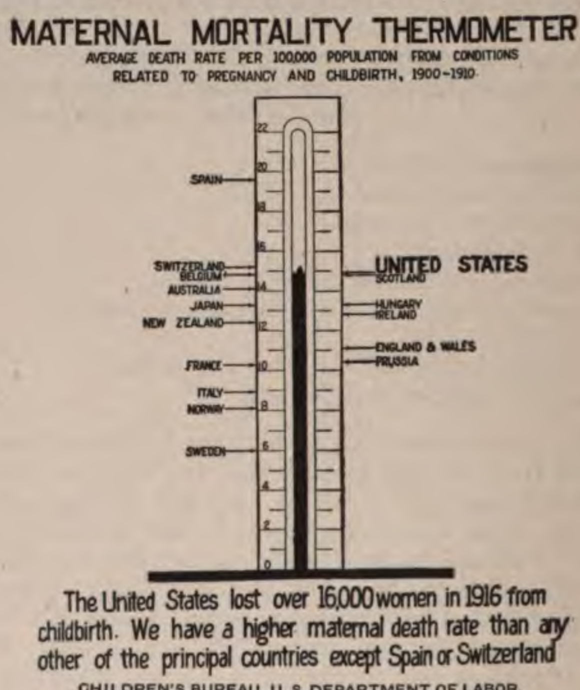

FIG. 112.—(*Bur. Pub.* 61.)

pointed out in 1843 that this fever was similar to wound infections and was chiefly due to the carrying of infectious material on the hands of attendants from one case to another. In 1847 Semmelweiss advanced similar ideas. Previous to this time the mortality from puerperal fever in maternity hospitals was appalling. Subsequent to the introduction of antiseptic treatment the mortality immediately fell until now in hospital practice maternal deaths are negligible as shown in the table:

TABLE X

Year	Hospital	Place	Confinements	Deaths
1907..................	Baudelocque	Paris	3,034	1.0
1907 (14 years previous)		Basle	6,000	0.08
1907-8................	Rotunda	Dublin	2,060	3.0

Yet despite the demonstration that the disease is unnecessary it is still with us and shows no apparent diminution. In hospital practice in the United States it is as rare as indicated by the foreign experiences, but among home confinements it is still apparently undiminished. While puerperal septicemia is undoubtedly the most clearly preventable disease of this group, yet a large proportion of the other deaths must be regarded as due to preventable causes.

Nearly 80 years ago Holmes showed that childbed fever was transmitted from patient to patient by the hands of the attendants. It is undoubtedly true that obstetric asepsis is drilled into medical students the country over. Why then these deaths? A formidable proportion of confinements in some localities, a major proportion in others, are not attended by physicians but by midwives. The degree to which the assistance of midwives is relied upon is largely proportional to the extent of the foreign born population. Thus during 1916 in the borough of Manhattan, 11,266 mothers were confined in hospitals and institutions and 47,384 in their homes. Of the latter, 19,524 or 41.4 per cent. were attended by midwives. These people regard the service of a physician at this time as an unnecessary expense. The majority of midwives have no special qualifications for their task in so far as training is concerned. Most can handle normal confinements but if complications ensue, call in a physician. They have no idea of asepsis or antisepsis, make unnecessary and frequent vaginal examinations and introduce unsterilized instruments as well as unclean hands into the parturient canal. The knowledge they possess of obstetrics is extremely rudimentary and is largely acquired in a haphazard manner, never from competent instruction. Is it any wonder that puerperal sepsis is still with us?

It probably will be a long time before the midwives disappear. If they are to be tolerated, the welfare of women demands that they acquire a reasonable competence in their profession. Some provision should be made for their formal instruction in

obstetrics and none should be permitted to practice without a license from the state. Death certificates for women who die in the puerperal state should record the name of the attendant during the confinement and those who show a disregard for asepsis, as manifested by the development of cases of septicemia, should be barred from practice.

Physicians cannot ignore the fact themselves that the instruction that medical students receive in obstetrics and obstetrical asepsis is inadequate. We cannot belabor the mid-wife and gloss over the defects in our own practice and teaching.

The women themselves need instruction in the necessity for good care at the time of confinement and prior thereto. Husbands must learn that money spent to safeguard the life of their wives and children at this critical time is spent wisely and for a stern necessity. Such service is worth a respectable fee, a consideration which prevents many from employing the services of a competent physician and nurse. Their meager circumstances only permit them to secure the uncertain assistance of a mid-wife. This is largely a problem of urban populations. The best solution appears to be through the agency of prenatal and maternity clinics.

Prenatal and maternity clinics are designed for the welfare of both the mother and child who without assistance would not receive adequate care prior to, during, or subsequent to confinement. They are of equal value in the elimination of infant mortality. They are variously maintained, either by hospitals, philanthropic organizations or health authorities. By educational propaganda efforts should be made to inform women of the assistance available and they must be encouraged to present themselves to the clinic some time prior to confinement for careful examination. If serious conditions are found arrangements for continuous observation and care must be made. In any event the prospective mother receives instructions in the proper physical care of herself and in making suitable arrangements for her anticipated child. Satisfactory results from attendance during the prenatal period are only secured where arrangements permit judicious home visiting to ascertain that the advice given has been understood and is being acted upon. Advice upon diet, clothing, exercise and care of the breasts is especially needed. At the time of confinement arrangements are made for the medical care of the mother if she is unable to provide for it herself, or if the presence of complications necessitates hospital care, to provide admission to the maternity wards. The prenatal work of the clinics very largely relates to the

proper care of the infant, and as such will be considered under infant hygiene. Co-ordinated cooperation with other charitable agencies is frequently necessary to enable an indigent mother to receive proper food.

Another group of women in entirely different circumstances usually fail to receive adequate care at this period. Usually the difficulty is not a question of good or bad obstetric care or inability to provide for a physicians services, but rather the inaccessibility of any assistance at all during this time. This is the condition which many women in rural districts must face, particularly in the extreme north and west where pioneer conditions prevail. Many children are born with no other attendant than the husband, a relative or neighbor. The nearest physician may be located many miles away and a hospital many miles further. With inadequate roads and means of communication it is not possible to notify the physician in time. Under these circumstances the cost of a physicians services may seem unnecessarily great and is frequently foregone. The problem of these women is difficult, but a solution seems available. It probably can satisfactorily be accomplished along these lines;

(*a*) The establishment of a rural nursing service centering at the county seat, with nurses especially trained to discern the danger signs of pregnancy.

(*b*) An accessable county center for maternal and infant welfare at which mothers may obtain simple information as to the proper care of themselves during pregnancy as well as of their babies.

(*c*) A county hospital with provision for maternity cases, for the proper care of abnormal cases and of normal cases when it is convenient for the women to leave their homes for confinement.

(*d*) Skilled attendants at confinement available to each woman.

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SECTION V

CHAPTER XXIX

DISEASES TRANSMITTED FROM PARENT TO OFFSPRING

Two dissimilar groups of diseases are here considered. The first includes those diseases due to infective agents in which it is possible for an invasion of the germ cells, or intrauterine infection of the foetus, to occur. Such is known to be possible in the care of syphilis, tuberculosis and small-pox. However with all of these such means of transmission is unusual, and is not the means by which the infection is perpetuated in the population as a whole. Such transmission is of greater importance in syphilitic disease than in the other two, either by reason of a fatal outcome to the fetus, or a permanent injury to those which do happen to be born at term. These infections from a public health standpoint have however, already been adequately considered.

The second group comprises the true examples of hereditary transmission from parent to offspring. By heredity we mean the transmission from parent to offspring through the germ cells of properties inherent or characteristics of the parent or of the parental stock. By disease in this connection we have reference to any departure from the normal, regarding the normal not as any fixed point, but as the limits between which any particular characteristics of the majority of individuals will fall.

The hereditary diseases in the strict sense may be divided into groups depending upon whether or not their transmission conforms with the Mendelian principles. We shall first consider those which conform to these laws.

DISEASES TRANSMITTED ACCORDING TO THE MENDELIAN INHERITANCE

Before considering these diseases it may be well to briefly review the more salient principles of mendelian inheritance.

Its principles have been found to hold true for all forms of life and we can perhaps illustrate it most conveniently by reference to the vegetable kingdom.

If the pollen of red flowered peas (male) is employed in fertilizing the ovaries (female) of a white flowered pea, the mature plants which develop from the seeds of this fertilization (hybrids) are all red flowering like their male parent. The red flowering characteristic is stronger in leaving its influence upon its offspring than the white flowering characteristic of the mother. The red characteristic is therefore said to be dominant and the white character recessive. The recessive character is not lost in the first generation of hybrids, but is only latent, as we shall find when those hybrids are crossed with each other. The offspring of those hybrids when brought to flower will not all be found similar to their parents, but will be arranged in groups according to very definite rules. In the first place three fourths of their number will be red flowered, *i.e.*, present the dominant characteristic, while one-fourth will be white flowered, that is, present the recessive character. The two groups are in a ratio of 3 : 1, sometimes called the Mendelian ratio. If now then like individuals of the third generation be crossed with each other, it will be found that among the progeny of the white flowers, only white flowered offsprings will occur in the fourth generation. On the other hand, of the progeny of the red flowers, one fourth will be as red as the original male parent, while one half will be less clearly red and show clearly that they are hybrids, and one-fourth will be white. Thus of the fourth generation, one-fourth will present only the dominant characteristic, one-fourth the recessive character and the remaining half, though appearing like the dominant, possess the properties of hybrids. (Fig. 113).

One may designate by the term determiner the unknown substance in the germ cells which determines in some way the different characteristics of an individual, such as the color of the skin, the kind of hair, mental traits, etc.

If each of two parents possess a given character and each one transmits the determiner for that character to their offspring, then the offspring will possess two determiners for a given character, one from each parent. Then, unless there is something to prevent it, this offspring will in turn transmit two determiners to its progeny. If the other parent of this generation also contributes two determiners the third generation

will possess four determiners for each character and so the numbers of determiners would multiply. This however is prevented by the division of the chromosomes in the germ cell before maturity is reached, in which it is assumed the determiners reside. Thus only one half of the determiners pass into each

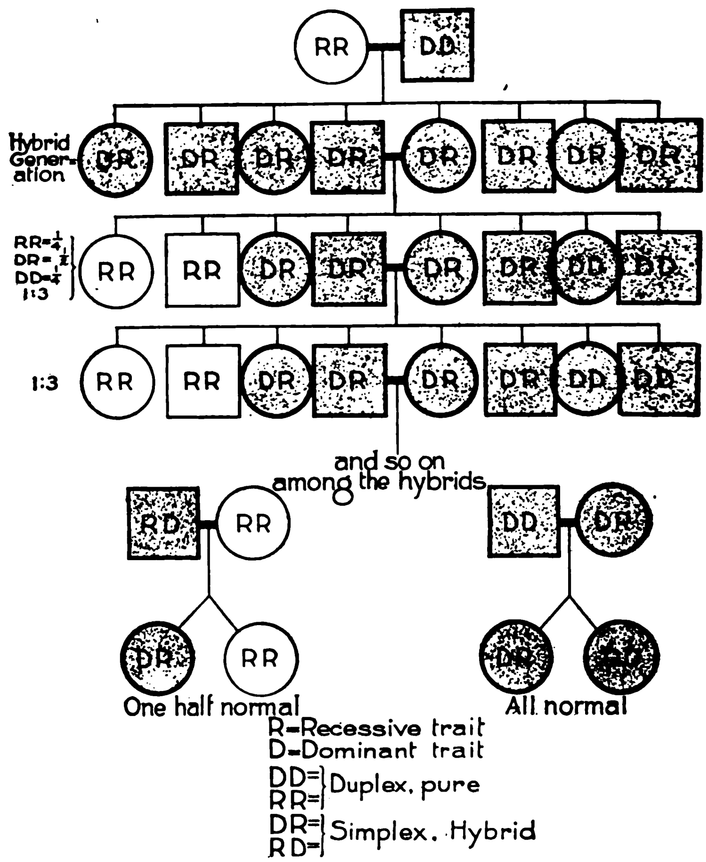

FIG. 113.—Mendelian inheritance.

mature germ cell and there is actually no increase. Therefore in the union of hybrid germ cells each containing one determiner for a given character, the determiners unite and depending upon whether they are similar or dissimilar, dominant or recessive, the offspring will according to our example, be either like the dominant male plant, the recessive female plant, or

the hybrids, which possess both the dominant and recessive determiners alone. The former we can designate as a duplex, the latter (the hybrids) as simplex combinations of determiners. Now when an individual who appears normal but has the dominant determiner in duplex is united with a hybrid, two kinds of offspring may result. One half will have the dominant character in simplex and one half in duplex but all will appear as normal. On the other hand if an individual with a recessive determiner in duplex, is united with a hybrid with one dominant and one recessive determiner, two kinds of offspring are likewise possible. One half will have one dominant and one recessive character each (simplex) but appear like the normal who has the dominant character in duplex and one half will have the recessive character in duplex and will not appear true to the normal type. (Fig. 113).

Certain diseases appear to be transmitted from parent to offspring by either dominant or recessive characteristics of the germ plasm. Their characteristics are briefly presented.

(*a*) **Huntington's chorea** is a condition in which there are marked involuntary, irregular contractions of the muscles leading to a more or less constant movement of the limbs. There is also dementia. It begins in middle life, affects both sexes about equally and is usually transmitted whenever present in either parent. It is therefore a dominant trait. Many of the cases in this country are traceable to several families belonging to an old New England colony.

(*b*) **Albinism** refers to a condition in which there is an absence of pigment from the skin, hair and eyes, a condition seen in white mice or rabbits. It is rare in man. It is undesirable since the lack of pigment makes the skin and eyes very sensitive to light. It is a typically recessive condition.

(*c*) **Deaf-Mutism** refers to a kind of deafness which begins early in life before the power of speech has been acquired, hence these individuals can neither hear nor speak. Fay has extensively studied this inheritance. Of 335 matings of congenitally deaf parents, 25 per cent. yielded deaf offspring. A total of 779 children were born of whom 26 per cent. were deaf. That all children of such marriages are not deaf is doubtless due to the fact that the parents are not deaf in the same way and one parent brings into the combination something which the other lacks.

(*d*) **Insanity** may result from various causes. Some cases are the result of organic brain disease. Such are not inheritable.

On the other hand with functional insanity without well defined lesions, some evidence of heredity is available. It is the tendency to insanity or the neuropathic trait which is inherited. It follows the laws of heredity governing recessive characters.

(*e*) **Feeble Mindedness** like insanity in many instances is a recessive trait. It is not always easy to determine who is and who is not a feeble minded individual. At one end of the scale we have those who are exceptionally able. In a general way we may say that a child is feeble minded who for no obvious reason at the age of ten is no further advanced in his school work than are other children at the age of six or seven. Within normal variations we may have children one or two years behind or in advance of the average.

Mendel's law is also exemplified by what are known as sex-limited diseases, examples of which are color blindness and hemophilia. These are diseases that appear almost only in the male line, but are transmitted only through the female line. Thus if a given man be affected, his sons will not have the disease nor will they transmit it to their offspring, nor will his daughters have the disease, but they will transmit it to their sons. The explanation of this is associated with the determiner from the male chromosome. Striking examples of this type of heredity are observed with multiple sclerosis, atrophy of the optic nerve, color blindness, myopia, ichthyosis, muscular atrophy and hemophilia.

DISEASES NOT CONFORMING TO MENDEL'S LAW

(*a*) **Friedreich's ataxia** begins in childhood and usually occurs in a family having other members similarly affected There are curious forms of incoordination, loss of knee-jerk, early talipes equinus, scoliosis, nystagmus and scanning speech. Since it has usually been observed as a family disease it is assumed to be transmitted hereditarily.

(*b*) Reversionary inheritance does not appear to follow the Mendelian laws. It represents a return of the offspring to a lower type, a development which is incomplete and corresponds to a stage characteristic of an earlier period in the development of the species, whether affecting the body as a whole, or only some particular portion, such as the nervous system. The typical degenerate is of poor bodily development, the brain is smaller than normal, with convolutions less abundant and less fully formed, possesses a degraded physiognomy, little capacity

for sustained attention or prolonged thought, is cunning rather than intelligent, is deficient in a moral sense; in all these characteristics resembling the lower, less developed types of our own species. Thus this type of inheritance is the reassertion of properties which have remained latent.

NATURAL IMMUNITY

Immunity is either natural or acquired. The former is inherited through successive generations in a species or race. Acquired immunity does not appear to be a transmissible characteristic, at least to such an extent that changes are rapidly observable in the span of a few generations.

EUGENICS

Eugenics is the science of the improvement of the human race by better breeding. The success of a marriage from the standpoint of eugenics is measured by the number of normal, cultivable offspring that arise. It has to deal with traits that reside in the germ plasm. The superstition of pre-natal influence and the effects of venereal disease lie outside the scope of eugenics.

In the foregoing paragraphs we have only sketched the hereditary transmission of certain undesirable qualities. If space permitted, a similar sketch of the hereditary transmission of desirable qualities could be presented. It is these eugenics desires to augment and to eliminate the undesirable. The science is in its infancy at present and our knowledge is but fragmentary. Some progress can be made among those of intelligence by propaganda explaining the known facts. Unfortunately among those possessing many undesirable characteristics such means of propaganda is impossible. Appeals cannot be made to the degenerate, to the criminal, to the feeble minded. The elimination of the hereditary traits of this character require the united action of society to stop the procreation of those who are unfit by reason of defective germ plasm. No real progress has been made in this direction but in some places a creditable start has been made.

Prohibition of the marriage of those possessing socially undesirable characteristics will not prevent the illegitimate procreation of such individuals. Such laws are manifestly inadequate. A solution that has been legally adopted in some

states is that of sterilization, but its enforcement has been limited. There is no question but that such a procedure applied to all the feeble minded, the epileptic, insane or criminal persons in the country would produce an enormous reduction in the institutional population in the course of a generation. The greatest difficulty lies in the satisfactory definition or accurate recognition of those whose procreative abilities should be sacrificed to the social welfare. An alternative solution is the segregation in institutions of such persons until the reproductive period has passed. We could expect the same results.

On the other hand, there is the group composed of those having defects not inimical to society. Some of those traits may involve the possession of severe handicaps, and it is perhaps better that such traits should become extinct. More satisfactory results in this direction can perhaps be accomplished through the persuasive powers of the family physician in whom the afflicted individual has confidence. The necessity or desirability for celibacy can be judged from the type of undesirable trait presented and a knowledge of the type of Mendelian inheritance followed.

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SECTION VI

SPECIAL ASPECTS OF HYGIENE AND SANITATION

CHAPTER XXX

HYGIENE OF INFANCY

The age period of infancy includes all those under the age of one year. This undoubtedly is the most critical period of life, during which the newly born is adapting itself to a new environment. It is not surprising that many have a great deal of difficulty in meeting the changed conditions encountered after birth and die. The deaths during the first year of life are higher than at any subsequent age period (Fig. 113*a*). In 1910 they amounted to 20 per cent. of all the deaths in the registration area. Ten per cent. of all deaths during the first year occur in the first day of life and 25 per cent. during the first month. Roughly 8 per cent. of infants born die during the first month of life. The proportion of all born which die during the first year of life varies from 10 to 35 per cent. From birth there is a steady decline in the mortality throughout the first year and when the second year is reached the mortality is only one-fifth of what it was in the preceding year. In recent years the deaths during this age period have been steadily falling. One or two hundred years ago they were simply appalling, even in the highest society. The appalling character of this mortality is heavily emphasized when we consider that a larger proportion, probably the majority of these deaths are preventable (Fig. 114).

THE CAUSES OF INFANT MORTALITY MAY BE ROUGHLY PLACED IN SIX GROUPS

The first of these includes the deaths due to prematurity, congenital defects and debility, and to accidents at birth. They are responsible for about 25 per cent. of the deaths. These are

largely due to parental influences, to diseases of the parents, such as syphilis and gonorrhea, alcoholism, overwork of the mother during the latter portion of the pregnancy, eclampsia, pelvic deformities and the maladministrations of incompetent mid-wives. Many of these are associated with the death of the mother. While the majority of the deaths in this group are not directly due to preventable causes, yet a considerable por-

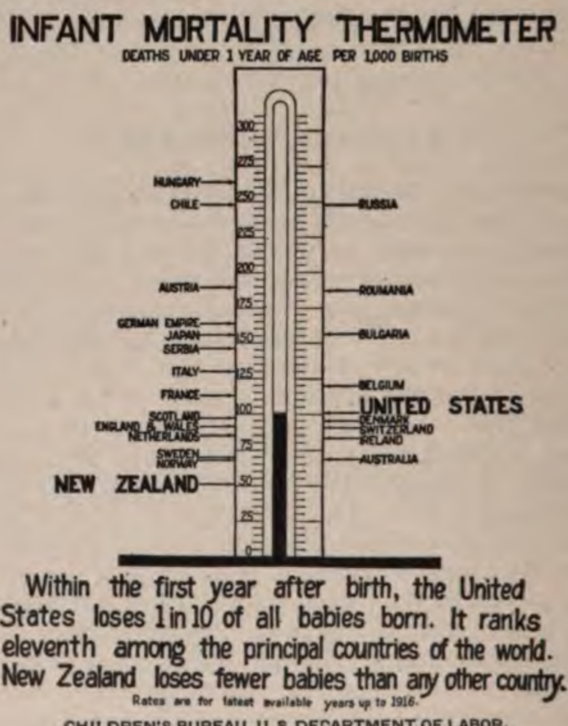

FIG. 113, *a*.—(*Bur. Pub.* 61.)

tion must be regarded as due to causes which are indirectly preventable.

The second group comprises the nutritional disturbances and the acute gastro-intestinal diseases. These are responsible for about 35 per cent. of the mortality. These must be regarded as primarily due to bad feeding. This fact is emphasized by finding that 85 per cent. of infantile deaths are among the bottle fed and further that 90 per cent. of the deaths from

diarrheal diseases are among those fed from the bottle. Bad feeding of infants is largely a question of artificial feeding, so as a consequence we must regard all deaths in this group as preventable. Closely associated with bad feeding is the influence of hot summer temperatures, which not only exercises a directly injurious influence on the baby, but also on the keeping qualities of his food.

The third group includes the acute respiratory infections, bronchitis, bronchopneumonia and lobar pneumonia. These

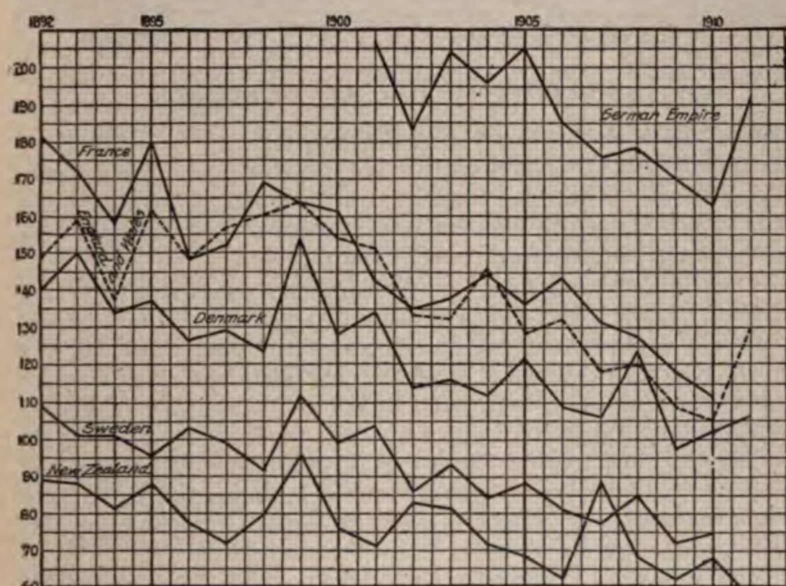

FIG. 114.—Infantile mortality (deaths of infants under 1 year of age per 1000 births per annum exclusive of stillbirths). German Empire, France, England and Wales, Denmark, Sweden, and New Zealand—1892 to 1911. (*Trask: Suppl.* 12. *P. H. Rep.*)

produce about 20 per cent. of the deaths. They largely arise as a result of overcrowding or bad ventilation.

The fourth group includes the acute infectious diseases. These at this age period are of lesser importance, causing only about 3 per cent. of the deaths. Whooping cough is the principal member of this group as far as infants are concerned. Fifty-seven per cent. of the deaths from whooping cough occur during the first year and 23 per cent. during the second year. An infant is susceptible from birth to whooping cough. To-

ward many of the other acute infections an infant presents a considerable immunity which persists for several months.

Tuberculosis, chiefly meningeal in type, causes about 2 per cent. of the deaths. Infants should not come in contact with adults having open lesions of tuberculosis, nor be fed upon the milk of tuberculous cows.

Syphilis causes only about 1 per cent. of the deaths. It operates chiefly as a cause of prematurity and miscarriages.

Nearly everywhere infant mortality is greatest in the most unsanitary and crowded areas. As a consequence the extent of infant mortality is a good index of sanitary conditions.

THE INSTITUTIONAL CARE OF INFANTS

The infant that is doomed to institutional care has very poor prospects in life. The majority are illegitimates and hence are unwelcome. While the mortality in institutions is high even with the best of care and the employment of wet nurses, while without wet nurses it may reach 100 per cent.

The following factors are principally responsible for this appalling mortality: (1) The institutions are usually overcrowded, so that respiratory infections run like wild fire; (2) There is a lack of sufficient fresh air; (3) Respiratory infections, whose dissemination is favored by overcrowding and defective ventilation, and lastly, (4) The lack of mothering. Babies thrive best, other things being equal, where they receive a great deal of individual, personal attention. They seem to require encouragement and coaxing over the period of their adaption to extra-uterine life.

The following conditions will largely reduce the mortality among this class of infants. Every effort should be made to induce the mother to keep her child. Its chances of survival are enormously improved, even though it is later placed in an institution. Institutions for the care of infants are usually privately conducted and commonly known as "Baby Farms" or boarding houses. These should be placed under the control and supervision of health authorities, so that abuses in their conduct may be eliminated. For this purpose their licensure is necessary. A practice that is preferable to the employment of boarding houses is that of boarding the babies in private families with wet nursing. This enables the infant to receive the necessary individual attention. Infant hospitals should be only for those acutely sick and should not partake of the

character of boarding houses. As soon as possible the child should be returned home. Every hospital which cares for infants should be provided with wet nurses. Wassermann tests should be made on both infant and nurse to prevent the transfer of luetic virus in either direction.

BREAST FEEDING

Breast feeding is essential to the really proper welfare of an infant. Its value is seen from the fact that breast fed infants seldom suffer from intestinal troubles. The extent to which breast feeding is practiced varies in different countries, districts of cities and with different races and customs. Thus in 1911 in Boston, only 68 per cent. of the infants were breast fed. It is possible to increase this proportion. Various causes, some justifiable, are responsible for the failure of some mothers to breast feed their offspring. Some are deliberately unwilling and regard it as an annoyance, while others do not appreciate its importance from the standpoint of their child's welfare. Others have to work away from home under conditions that do not permit them to take their child. Some are physically unable to nurse because of lack of milk. The glittering advertisements of proprietary foods lead others astray.

These obstacles can largely be overcome. Pregnant and nursing women must be educated in the importance of breast feeding. Certain classes of mothers, especially those whose children most require assistance, can be reached through prenatal clinics and child welfare conferences. Employers of married women should make provision for mothers to bring their babies to work. Indigent mothers who are unable to secure sufficient food for themselves, let alone a baby in addition, require charitable assistance.

ARTIFICIAL FEEDING

If artificial feeding is properly carried out most babies will thrive upon it. The difficulty lies in the fact that it is frequently, if not usually. improperly carried out. Difficuties arise from the fact that a poor grade of cows milk may be the only milk available, improper modifications may be employed, the milk may be inadequately kept or is spoiled and the bottles and nipples may be neglected.

Proper artificial feeding requires the following conditions.

An adequate supply of either pure raw cows milk of certified grade or pasteurized milk must be available. Charitable organizations should make provisions either for its free distribution or its distribution at a reduced price to indigent mothers. Similarly ice supplies for its proper keeping in the home should also be available. In the absence of regular refrigerators, simple devices can be employed for the refrigeration of the milk. Attention has been called to these in the section on milk. Mothers should be instructed in the proper care of the milk and of nursing bottles. Proper modification of the milk is essential. Many physicians are not familiar with proper procedures for the adaption of cows milk to infant feeding. Proper education of physicians in these procedures in order that they may in turn properly instruct their patrons is necessary. Parents may also be instructed in milk modification at prenatal clinics and child welfare centers.

CHARITIES AND CLINICS

We have already called attention to the value of prenatal clinics in the education of expectant mothers. These organiza-

FIG. 115.—Everything prepared for a demonstration of baby care (Stamford, Conn.). Such demonstrations are of great value in educating mothers in infant care. (*Children's Bureau Pub.* 15.)

tions are scarcely of less benefit in the education and supervision of mothers after the birth of the baby than they were before

the event. Advice and assistance on all subjects relating to the child's welfare is given. Child welfare centers offer similar assistance and instruction (Fig. 115).

Many notable milk charities have been organized. These provide satisfactory modified milk at a cheap price or free of charge.

Of inestimable value in the education of mothers and in the reduction of infant mortality are the services of visiting nurses. These women serve either under the auspices of some local philanthropic organization or the local health authorities. Their principal work is in the infant's home. It is in this connection that the prompt registration of births is of great value in the control of infant mortality. These nurses visit all homes from which births are reported within a week or ten days. They ascertain if the mother needs advice or assistance. This if required is given, or if financial assistance is necessary they direct the mother to the proper source of the needed help. Regular follow up visits are made to see if the mother is properly carrying out the advice. Women for successful work in this field must possess a great deal of tact and diplomacy. The results of this work are exceedingly beneficial.

HEAT

The extreme heat of the summer months makes this period very trying for infants. This is especially true where the effects of the heat are exaggerated by overcrowding, by reflected and absorbed heat from buildings and pavings, and where ventilation is inadequate. It exercises a directly depressing effect on a child's vitality. The heat also prompts the growth of putrefactive bacteria in the child's milk, which tends to increase the frequency of digestive disturbances. An abundance of flies and the absence of fly protection assist in the spread of diarrhea and dysentery. Great care should be given the child's food, it should be kept as cool as possible and protected from flies. Furthermore many mothers constantly overclothe their babies during the summer.

INFECTIONS

We may call attention again to several communicable diseases of especial importance to infants. First, the severity of whooping-cough. Second, that ophthalmia neonatorum which

causes about one-fourth of all blindness, can be effectively avoided by the employment of Credé's method of prevention with silver nitrate. And lastly small-pox vaccination is best given for the first time in the first year before the second summer. It may be safely given when the child is one month old with less discomfort than an adult experiences.

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CHAPTER XXXI

HYGIENE OF CHILDHOOD

By the term childhood we refer to the age period from infancy to puberty. As measured by the death rate, this is the most hardy period of life, being less than at any other age period. The hygienic development of the child during this period is indirectly of great importance as it will profoundly influence the physical welfare of the individual as an adolescent and adult. We will briefly consider the more salient of the hygienic hazards which confront the child:

COMMUNICABLE DISEASES

During the months immediately following birth there is a temporary immunity toward measles, scarlet fever and diphtheria. This disappears during infancy, so that by the time childhood is reached the individual is susceptible to nearly all of the acute infections. Thus we find that certain diseases have their greatest age incidence at this period of life, namely, measles, german measles, mumps, chicken pox, diphtheria, scarlet fever, poliomyelitis, meningococcic meningitis, etc. This peculiar maximum may perhaps be due to either or both of the following factors, namely (1) to the susceptibility of the children, or (2) to the greater opportunities which exist among children for the transfer of infective secretions by the agencies of contact. On the other hand, infection with *Mycobacterium tuberculosis*, whose presence is most commonly manifested by clinical tuberculosis during adolescence and early adult life, is received during childhood.

ORTHOPEDIC DEFECTS

These are deformities arising from faulty posture, and the types we shall consider are functional in character. They chiefly arise as a result of prolonged periods of seating, such as a child is forced to maintain at school.

(*a*) The most common of these is the so-called "Round Back." It is manifested by a prominent abdomen, a back-

ward convexity of the spine, a contracted chest and a ptosis of the viscera. The foot is usually everted outwards. It gives the individual the appearance of leaning backwards. Its contributing causes include poor nutrition, hard physical work and poor postures. Its development is assisted by poor clothing such as the continuous drag which elastic garters exert when suspended from the shoulders. It may be remedied by properly suspended clothing, by proper seats and the inauguration of relaxation periods which include setting up exercises.

(*b*) The second group includes the functional lateral deviations or scoliosis. All functional scolioses are single curvatures of the spine. The most common type is where the convexity of the spine is to the left. These produce an elevation of the right crest of the ileum, a waist line indented more on the concavity (right side) of the curve, the opposite (left) shoulder is higher and rotated forward, the right (concave) side is seen to be higher or more prominent. With deviation to the right, which includes only about 10 per cent. of the cases, the above conditions are reversed. All of the above conditions must be observed for a diagnosis. It is correctable by proper gymnastic exercises, but if uncorrected may lead to structural changes.

OCULAR HYGIENE

The ocular conditions of greatest importance during childhood include the acute infections and eye strain. Among the former, various forms of acute conjunctivitis and trachoma are of importance. School and household epidemics of these are not unusual, due to the exchange of infective secretions by contact. While acute conjunctivitis may lead to a permanent impairment of vision, trachoma is of far greater importance and less easy to control.

Eyestrain or defective vision may be due to either hypertropia or myopia, astigmatism or muscular insufficiency and strabismus. These should be properly corrected by refraction measures or surgical procedures. When uncorrected they hinder a child's progress inasmuch as it is impossible for him to follow the work of his class intelligently.

AURAL HYGIENE

The conditions of the ear of greatest importance are discharging ears and defective hearing. Discharging ears should receive suitable medical treatment, while those having defective hearing should receive preferential seating in class rooms.

HYGIENE OF THE NOSE AND THROAT

A remarkable and close correlation exists between the condition of a child's nose and throat and the degree of intelligence it manifests. The reasons for this correlation are not apparent. One would expect to find such a correlation to exist with hearing and vision but such is not the case in our experience. The conditions of greatest importance and most common occurrence are sore throat, hypertrophied tonsils, adenoids and nasal obstructions. These require suitable medical or surgical treatment for alleviation.

DENTAL HYGIENE

Faulty conditions of the nose and throat may profoundly influence the dentition. Thus adenoids will interfere with the development of the jaw and produce irregularities of the teeth.

Decay or caries of both the first and second dentition is common and very important. The fermentation of carbohydrate materials in food particles lodged between the teeth results in the production of lactic acid, which is a solvent for dentine and enamel. Soft carbohydrate foods rather than hard tend to lodge in these situations. Their lodgment is favored by the buccal mucous. The vigorous mastication of hard carbohydrate foods will overcome a great deal of this difficulty.

Pyorrhea is an important dental defect whose cause and prevention is unknown.

Pus pockets about the roots of decaying teeth are of greater importance than their small size and localization would at first indicate. They are one of the most common seats of focal infection and a situation from which infective emboli gain access to the circulation and produce disorders elsewhere. Their recognition and elimination is of great importance.

It is advisable to make inexpensive repairs to the early teeth, as their premature disappearance may unfavorably affect the second dentition. The use of the tooth brush should be made a regular habit.

NUTRITIONAL DEFICIENCIES

Children whose state of nutrition is subnormal show a distinct lack of subcutaneous fat, they are under weight, thin, pale and have pinched faces. The condition may be due to a lack of good food, or to insufficient or improper food, to indiges-

tion or improper mastication. Or it may also be due to a lack of fresh air associated with overcrowding, a lack of rest or overwork, tuberculosis or diseases of the liver and kidney.

Each of these possibilities will demand investigation and special treatment if detected. Where due to insufficient or improper food the economic status of the parents is usually the important factor. Some means of charitable relief is temporarily required. One solution employed is to provide simple lunches at a low price at school.

SCHOOL SANITATION

This question is important, inasmuch as the schools concern all children. Furthermore the close association between susceptible children at school makes the school an important

FIG. 116.—School with insufficient windows. The windows are not large enough to provide sufficient light. They should be more numerous and the window panes larger. (*Public Health Reports, Sept.* 11, 1914.)

clearing house for communicable diseases. The many important features in school sanitation can only be lightly touched.

(*a*) **Lighting.**—A general and safe rule is that lighting space should be provided in each room in the proportion of one square

foot of window space for each five feet of floor space. In locating the seats it is important that the lighting come from the left and that none be permitted to shine directly into the eyes when the individual is properly located in his seat (Fig. 116, 118).

(*b*) **Heating and Ventilation.**—The maintenance of the proper mental and physical efficiency in the children requires that the teachers maintain proper conditions of temperature

FIG. 117.—A dangerous school privy. Cover to seat of privy and door to entrance are lacking, thus allowing access to flies and animals. Excreta are deposited upon the ground, thus bringing about soil pollution. Thirty-eight out of forty children in this school were found to be infected with hookworm. The percentage of hookworm infection in the county in which this school is located was 82.6. (*Public Health Reports, Sept.* 11, 1914.)

and humidity in the class rooms. This can be accomplished by careful supervision, but is frequently ignored.

(*c*) Blackboards selected for recitation or demonstration purposes should be so situated that no light is reflected from their surface into the eyes of the pupils. These should have a dull black surface.

(*d*) A hygienically satisfactory supply of individual drinking

cups should be available or drinking fountains should be used. Common drinking cups should not be tolerated.

(*e*) Adequate toilet facilities with separate toilets for the sexes are necessary. These should be maintained in a state of proper cleanliness and working order. Washing facilities and individual towels are also necessary. Teachers should require their use by children who come to school with dirty faces and hands (Fig. 117).

(*f*) Proper seating of the children with regard to their stature and the seats available is necessary. This is important from the standpoint of orthopedic development.

Fig. 118.—Front of classroom, Cross Roads school. Note the relation of the seating and black boards to the illumination. (*Bureau Education, Bull.* 12, 1914, Plate 22.)

(*g*) The method employed for cleaning class rooms should avoid unnecessary dust production and should preferably be done at the close of the school day. Common books and pencils tend to favor the distribution of infective agents and are undesirable.

(*h*) Provision should be made for one or more periods of physical relaxation during the school day. These may be devoted to drills, games, deep breathing exercises or a recess.

In the arrangement of the curriculum the analytical courses should receive first place, so that they are taken while the mind is fresh.

SCHOOL INSPECTION

The medical inspection of school children is variously under either the Board of Education or the Board of Health, or in some places is accomplished jointly. As a method it was especially introduced for the purpose of controlling communicable diseases by the regular and frequent inspection of the children to detect mild cases, carriers and convalescents, and to secure their exclusion from school until no longer infective. The results secured in this direction are very satisfactory. It permits the rapid checking of an epidemic without serious loss of time or the disorganization of the school work. The dismissal or closure of the schools for an indefinite period as a measure of disease control has little to commend itself.

A more recent development of school inspection is the extension of its scope to include the physical defects of the children and make available provision for their correction. The scope of the examination made is most commonly limited to the ears, eyes, nose and throat, teeth, deformities, nutrition and mentality. As a rule the methods of examination employed are necessarily not as detailed as those in ordinary clinical work, due to the lack of time and assistance. Their purpose is to call to the attention of the parents the existence of defects and to emphasize the need for their correction. The examinations should be made by a competent medical man and follow up work at the children's homes is best accomplished by nurses. They endeavor to enlist the cooperation of parents so that the suggestions offered by the examiner are carried out.

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CHAPTER XXXII

AIR: HEATING AND VENTILATION

1. Air is man's immediate environment and in relation to health serves two important functions. The oxygen supply which it furnishes may justify us in regarding air as a food, while it also serves an important function in the regulation of the body's temperature. It varies in the following directions:

(*a*) **Chemical Composition.**—This is very constant out of doors all over the world. Variations in outdoor air are slight and are only found over small areas. On the other hand, the composition of indoor air is very variable, due to the constant admixture with expired air. It is a simple physical mixture, the approximate proportions being shown in the following table, ignoring rare and unusual constituents.

	Outdoor air per cent. by vol.	Expired air, per cent. by vol.
Oxygen	20.81	16.03
Nitrogen	79.15	79.55
Carbon dioxide	0.03	4.38

(*b*) Temperature and pressure show seasonal and altitudinal variations.

(*c*) The possible moisture content varies directly with the temperature and pressure.

(*d*) Odors are variable, being more numerous and concentrated in indoor air.

(*e*) Air is subject to rapid movement, and to rapid changes in its temperature, pressure and moisture content.

Air must be regarded as a most necessary and essential food. In this respect the nitrogen serves as a harmless diluent for the active oxygen, the essential constituent. The oxygen effects the combustion of the food eaten and stimulates digestion and metabolism.

2. By **good air** is meant air that is free from dust, smoke and odors, of moderate coolness and humidity, free from accumula-

tions of respiratory products and body excretions. It is usually outside air, the air of rural, residential or unsettled areas.

3. By **bad** or **injurious air** is meant air that produces discomfort, which is chiefly caused by heat and humidity, and odors in the air of inclosed spaces. Odors are the chief cause of discomfort and their intensity is increased by heat and humidity. Ordinarily these conditions are due to the self pollution of air about a sedentary person, the aerial blanket about the individual being saturated with his excrement. Odors are of two types, extraneous and intrinsic. Extraneous odors include those due to gas works, bone boiling plants, rendering plants, slaughter houses, stables and meat markets. Intrinsic odors arise from the sudoriferous glands, from bad teeth, bad breath, gases from the stomach and rectum, or urine decomposing on the clothing. These are not detectable on chemical analysis. The necessary temperature and humidity to accentuate odors may be produced by the body, the heat being furnished by direct radiation and the humidity from the expired air and perspiration.

4. In addition air may contain certain various undesirable or injurious substances not due to respiration. Thus there may be present dust from various sources (metals, stone, wood, soil, manure, cotton, wool, etc.) soot and smoke. The latter are products of combustion and add sulphurous acid and carbon dioxide. The air of industrial establishments may be contaminated by dust and fumes of varying kinds. These have already been considered.

5. **Effect of Temperature and Humidity.**—The human body is readily adaptable to temperatures from 0 degrees F. to 80. degrees F. Temperatures above or below these limits produce discomfort. Discomfort from both of these factors arises from the disturbances they produce in the heat regulating devices of the body. The bodily activities produce an excess of heat which must be lost or heatstroke will result. Heat is lost by (1) heat transfer which is affected by radiation, conduction, and convection, and by (2) evaporation (perspiration) whose amount diminishes as the surrounding humidity and temperature rise. Without free perspiration the temperature of the body rises if the external temperature goes above 70 degrees F. As long as free evaporation persists the heat production and heat loss are balanced. When humidity is high evaporation is lessened and the balance is maintained by an increased flow of blood to the skin and consequently an increase in the loss of heat by transfer. Humidity affects the heat output

by (1) increasing the conductivity of the atmosphere for neat (thus cold moist air is chilling) and (2) interferes with the evaporation of perspiration (thus warm moist air is ennervating). Around a temperature of 68 degrees F. humidity exercises a minimum influence. Humidity should not exceed 70 degrees F. as measured on a wet bulb thermometer. Temperature and humidity are perhaps the most important factors in ventilation.

Warm moist air is not directly injurious. Chilling on leaving such an atmosphere may occur. When air about 80 degrees F. becomes saturated, evaporation no longer compensates for the decreased radiation and heat stroke may follow the rise in body temperature which follows. The effect of this temperature is diminished by light clothing.

Cold damp air is injurious to poorly clad, improperly fed persons either in infancy or old age, or to those having kidney disease, rheumatism, disorders of metabolism or affections of the respiratory passages. Its effect is diminished by proper clothing, exercise and an increased diet.

Warm dry air produces the most comfortable sensations and is stimulating. Hot dry air causes an excessive loss of moisture and favors irritation and infection of the respiratory mucosa.

6. The relation of man to air varies in different climates. Thus in the tropics he needs no fire for warmth, no clothing except for modesty and no work to keep warm. The heating and ventilation of the home is of little consequence, since there is little home life. On the other hand in the arctics fires are needed for warmth, while fuel is scarce, and heavy clothing is required to conserve the body heat. As a consequence both heating and ventilation of the home is required. The temperate climate furnishes both of the above extremes during its seasonal variations.

7. **Carbon Dioxid.**—Carbon dioxid was formerly considered injurious and also an index of the wholesomeness of air. It is not irritating or poisonous. Its percentage cannot be taken as a guide to the fitness of air for breathing, and we can only employ its determination as a guide to the amount of rebreathing (vitiation) which has taken place, while it cannot be substituted for the more important determinations of temperature, humidity, and motion. Ordinarily it never accumulates in quantities sufficient to cause injury. It is tolerated in quantities up to .10 to .13 per cent.; from 2 to 3 per cent. produce increased respiration, from 7 to 8 per cent. produce

distressing dyspnoea and 10 to 11 per cent. produce headache, nausea and chilliness. Suffocation will occur in an atmosphere of 30 per cent.

8. **Heating.**—The body must be regarded as a furnace, a radiator, a thermostat and a humidifier. It not infrequently produces more heat than is needed, whereupon no external heat is required. Less artificial heat is required by young persons, women, and by all persons when exercising. In sedentary life and old age the heat loss is in excess of heat production and then one needs to surround the body with an air blanket of a temperature that in winter will supply heat to the body. The young and active require an air blanket that will absorb heat. Thus a study should be kept warm and a gymnasium cool. Next to the body is a partial blanket of air enmeshed in the hair and clothing, which serves as an insulator. This is present except when a person is exposed to winds. Thinly clad persons, or persons who are poorly nourished, tend to overheat their dwellings, due to insufficient bodily heat production.

Artificial heating as a practice antedates ventilation. At present, especially in large buildings, the two are frequently combined but it is a difficult matter to secure satisfactory results. Artificial heating is usually with dry air. The capacity of winter air for moisture is greatly increased after heating, for when cold, even if saturated, it contains relatively little moisture. Artificial humidification is therefore required.

Artificially heat is supplied by various means; (1) by open fire places, (2) by stoves, (3) by hot air furnaces, (4) by the enclosed circulation of steam and hot water, (5) by gas and oil stoves and braziers and (6) by electrical heaters. The first two of these methods usually improve the ventilation of the heated spaces, since the source of the heat is an open flame within the room, which requires a current of air for its active burning, and in order to avoid the smoke the gases are conveyed outside. These currents result in fresh air being drawn into the room from out ot doors, Gas and oil stoves vitiate the air, since their gases of combustion are discharged into the room. If maintained in a small room actual danger may arise, due to high concentrations of carbon monoxid accumulating near the floor.

9. **Ventilation.**—The purpose of ventilation is to maintain the air of enclosed spaces in a condition that will result in the comfort of those using it. It does not necessarily imply the

displacement of air, but should provide for its motion. It is impossible to make estimates of the proper allowance or condition of air by any cubic foot per capita allowance. If the air in an enclosed space is maintained at not over 68 degrees F., without excess humidity and in slight motion a person will be confortable and the air can be rebreathed many times without discomfort.

In a consideration of the air in enclosed spaces attention should be called to both the breathing zone and the breathing cone. The breathing zone in a room includes the air lying within those limits from which a person draws air while either sitting or standing. If the air is stagnant and contains much smoke its limits will be visibly defined. The breathing cone consists of a more or less conical zone of rebreathed air surrounding a sedentary person, whose apex is at his nostrils. The circulation of the air of an enclosed space breaks up these local concentrations of respired air.

Ventilation is either natural or artificial. Natural ventilation is due to either: (*a*) gravity and diffusion, or (*b*) perflation and aspiration. The former represents the diffusion of air into a room through porous walls and the spaces around doors and windows. The warm air escapes and is replaced by cool air. It is important in the ventilation of small rooms. Perflation is the ventilation secured by the removal of obstacles to wind pressure, such as that accomplished by the opening of windows. The effect of aspiration is shown by the air currents in flues and chimneys. It is assisted by the provision of movable chimney cowls which turn the vent away from the wind.

Mechanical ventilation is the propulsion or extraction of air by means of fans or blowers whose operation is continuous. It is of two types: (*a*) the plenum system and (*b*) the vacuum system. In the first the air is forced in by a blower, having an intake at the ground level. In the second the air is withdrawn by an exhaust fan and the intake is secured by the seepage of air through walls and around windows. It gives rise to drafts. The plenum system is used in connection with heating systems and automatic thermo-regulation. As a rule it does not work satisfactorily if influenced by factors of natural ventilation. The air at the intake is washed to remove dust and also to humidify it, warmed by passage over steam coils and distributed through ducts. The best diffusion is secured where the discharge of warm air is near the ceiling, and the outlet is on the same wall

near the floor. Both systems so far are only practicable for large buildings.

10. **The Management of Halls and Large Rooms.**—It is possible to so manage these enclosures during winter months that a large audience will be comfortable and alert during the period of their congregation. Good results will be secured if the hall is filled with fresh air at about 60 degrees before the audience congregates. The intakes are then closed. The audience should be watched closely and if a slight general coughing starts or if a scattering of women clear their throats, a little heat should be turned on.

In hot weather every endeavor to secure the beneficial effects of perflation by removing all obstacles to wind pressure should be made. In enclosed halls and theatres where such is not possible the installation of artificial cooling systems based upon the circulation of cold brine, is of material value.

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CHAPTER XXXIII

CERTAIN ASPECTS OF PERSONAL HYGIENE

Many references to the care of the body in order to promote its proper functioning have already been made on previous pages in connection with some phase of preventive medicine. Here we shall briefly consider topics not heretofore mentioned.

EXERCISE

By exercise we mean the functional activity of the body, particularly muscular activity. The individual is in relation to the outer world in two respects, (1) by the sensations received, and (2) by muscular efforts which produce environmental changes. The muscular tissues make up most of the body bulk and are the seat of most of the metabolism. The body is so constructed as to be adapted to muscular exertion which is necessary for the maintenance of the body in normal condition.

INFLUENCE OF EXERCISE

(*a*) **On Metabolism.**—Exercise burns up carbonaceous material but does not increase the nitrogen consumption. The chief carbonaceous fuel is dextrose, which is stored up as a reserve fuel in the liver in the form of glycogen. During exercise the dextrose is oxidized to lactic acid, and if sufficient oxygen is present, to carbon dioxid. Not only does exercise bring into activity the muscular tissues, but all the other organs of the body as well. These activities involve both anabolism and katabolism. If exercise is so great that anabolism cannot build up what katabolism destroys, the individual loses weight.

(*b*) **On the Flow of Blood and Lymph.**—This is at a maximum during work, due to an automatic dilation of the blood vessels in the muscles. This is assisted by the pumping effect which the rhythmic heart action has on the veins.

(*c*) **On the Heart.**—The heart readily adapts itself to exercise. This is accomplished by the metabolites, and by cerebral impulses to the skeletal muscles which inhibit the vagus tone.

(*d*) **On the Arterial Pressure.**—This is increased, due to a constriction of the splanchnic vessels to compensate for the dilation of the cutaneous and mucular vessels, thus increasing the pressure. The amount of the pressure varies with the exercise. Its function is probably to supply a head of pressure, so that if there is a demand on one part of the body the blood may flow there without leaving the rest unsupplied. A blood pressure of about 90 mm. of mercury will produce a decreased muscular efficiency. In a healthy person exercise will immediately cause the pressure to rise, it then soon falls somewhat to a constant level which is maintained during the period of exercise, then falls below normal with rest and gradually is restored.

(*e*) **On Respiration.**—The carbon dioxid produced causes a deepening and quickening of respiration.

(*f*) **On Heat Production and Regulation.**—The increased fuel consumption of exercise results in the production of considerable heat. This requires the action of the heat regulating mechanism, so that the body temperature will not ascend too high. Exercise may cause a rise of as much as four degrees Fahrenheit above normal.

(*g*) **On Perspiration.**—The stimulation of the sweat glands causes an increase in the amount of perspiration. By this means water and salts, chiefly the former, are eliminated.

(*h*) **On Digestive Processes.**—Digestion and absorption go on equally well with rest and muscular exercise. On the other hand, exercise increases the appetite and decreases constipation by stimulating the activity of the colon.

(*i*) **On Slumber.**—This is promoted by the development of a healthy fatigue.

(*j*) **On Muscular Tissues.**—Those tissues not involved in exercise undergo an atrophy. On the other hand, exercise increases the size of muscle fibers but not their number. If the muscular fibers are overworked, permanent shortening results and the individual is said to be "muscle bound."

EFFECTS OF EXERCISE

Exercise produces the following effects which may be regarded as favorable, namely, an increase in the size of the exercised muscles, increased anabolism and a healthy fatigue. The following conditions that can result from exercise may be considered injurious, namely, pain from muscle soreness, muscle

binding, production of inguinal and femoral hernias, and probably it also serves as a factor in the production of arteriosclerosis.

Exercise should never be excessive or potentially injurious. Of this the individual is the best judge. It should be avoided in conditions of great fatigue and in cardiac, vascular and pulmonary disease it should be employed with great caution. Interest in exercise is desirable. It is for this reason that locomotory games are hygienically valuable.

FATIGUE

This is the weariness resulting from muscular or functional activity. The vegetative activities of the body, such as the nutritive functions, reproductive activity, smooth muscle action, glandular activity, etc., are not subject to will power. These activities set their own pace and therefore are not subject to fatigue. On the other hand, the animal activities, including work and locomotion, are subject to the will and stimulation and may thus be set to limits beyond the individual's own welfare. The receptors, neurones and muscles are the sites of fatigue.

(*a*) **Receptor fatigue** is fatigue of the end organs. We may particularly distinguish fatigue of the olfactory, auditory and optic end organs. Some odors affect the ability to distinguish similar or other odors, which must be considered a manifestation of fatigue. *Auditory fatigue* only affects the ability to hear sounds in higher register. *Optic fatigue* is manifested by a reduced visional acuity.

(*b*) **Neuron fatigue** occurs centrally, the axone being considered indefatigueable. Morphologic changes in the nerve cells and nucleus with a chromatolysis are observable, and physiologic changes, as shown by a rise in the threshold value between neurons, are seen in the spinal reflexes.

(*c*) **Muscle fatigue** may reside in the end plate or muscle fiber. The end plate may be fatigued while the muscle is still capable of contracting. The muscle contraction varies with constant or variable loads. With a constant load the contractions will finally cease, while with a variable load they will go on indefinitely. The rate at which they contract is as important as the load in the production of fatigue. The fatigued muscle is less irritable to stimulation, but increased stimulation will produce an increase in the height of contraction. The

reaction of the muscular protoplasm changes to acid from neutral or alkaline, due to the formation of sarcolactic acid and monopotassium phosphate. The acid is dissipated by outward diffusion, or oxidation to carbon dioxid. As a consequence lactates and lactic acid may appear in the blood and urine following fatigue. Muscular fatigue is due to the accumulation of these waste products in either the muscles or the blood. If in the muscle their accumulation may be due to the failure of the blood stream to remove them. The massage of a fatigued muscle assists in the removal of the fatigue products by the circulation. Recovery is also hastened by oxygen. The accumulation of fatigue products in the blood affects muscles other than the ones involved in the exercise, thus local fatigue becomes general.

Fatigue is temporarily overcome by excitement. In both laziness and fatigue work is done with a sense of effort, probably due to a rise in the threshold value, and to the accumulated waste products. When the threshold value of the neuro-muscular junction rises as fatigue progresses, the innervation spreads to other groups of muscles in order that the work may be accomplished. This brings more nerves and muscles into play and increases the amount of metabolites in the circulation and hence produces a greater sense of fatigue. As fatigue appears the movements of the muscles become less exact and their co-ordination is less perfect. This has a bearing upon industrial accidents as shown in the following figures.

TABLE XI

INDUSTRIAL ACCIDENTS IN THE GERMAN EMPIRE, 1887

Morning		Evening	
Hours	No. of accidents	Hours	No. of accidents
6–7	445	12–1	587
7–8	794	1–2	745
8–9	815	2–3	1,053
9–10	1,069	3–4	1,243
10–11	1,594	4–5	1,178
11–12	1,590	5–6	1,306

Fatigue also reduces the rapidity and accuracy of action and also diminishes the extent of mental control. There is also an increase in irritability and irascibility. Garrulity and

uncontrollable laughter may appear to an extent which is almost hysterical. Normally fatigue is a protective sensation indicating the need of rest. It reduces the general sensibility of the body.

Nervous fatigue, on the other hand, involves the activities of the central nervous system itself. It is of importance because the changing racial habits of our times require constant alertness, necessitating quick adjustments rather than much muscular work.

REST OR RELAXATION

Rest permits the accumulations of waste to be excreted and the destroyed material to be replaced. The greatest rest is achieved during sleep. Sleep is favored by warmth and quiet, especially toward the senses of sight and sound, "comfortableness," and complete relaxation. It is also aided by a neutral bath or any dull monotonous sound. Brain workers need less sleep than laborers. Eight hours is the average duration of sleep normally.

A change of work also permits of rest, especially with mental work. Long periods of mental work are unfavorable to muscular work and vice versa. If either are in excess one had better rest than change from one to the other.

BATHING

The sebaceous and perspiratory secretions of the skin require more or less frequent removal. This is best accomplished by bathing or washing the body in water. Those localities where the sweat is most likely to be poured out should be bathed daily in order to prevent accumulations which produce unpleasant odors. Furthermore a clean skin is less likely to be diseased than a dirty one. Bathing reduces the likelihood that body vermin might be able to establish a foothold. Too strongly alkaline a soap should not be used or the skin will become dry. The oil removed should be replaced by inunctions with lanolin or cocoa butter. Lastly the bathing of the hands and face, especially before eating and the avoidance of introducing the fingers into the mouth until after they have been washed, is an important safeguard against the introduction of infective agents by contact.

The 250,000 cold spots and the 300,000 warm spots are stimulated by temperatures differing from that of the body.

Thus in bathing the skin is stimulated by thousands of afferent stimuli. Baths are designated according to their temperature as follows:

Cold	65 degrees F.
Cool	65–80 degrees F.
Tepid	80–90 degrees F.
Warm	90–98 degrees F.
Hot	98 or over.

Cold baths stimulate and are employed for that purpose. A reaction is induced by an exposure to cold of from ten to thirty seconds duration. The immediate effect consists in the dilation of the internal blood-vessels, a contraction of the cutaneous vessels, "goose flesh," cutaneous pallor, a sensation of cold, shivering, an increased heart rate which soon decreases, with a decreased respiration. The secondary effect is known as the reaction. It is manifested by a slow and deep respiration, a reddening of the skin as the blood returns to the surface, accompanied by a feeling of warmth, perspiration and a sense of exhilaration. A warm body and skin before the bath tends to favor the reaction. The temperature of the bath should be as cold as may be tolerated. Cold baths should not be employed in infancy, old age, exhaustion, or fatigue.

Hot baths are better for purposes of cleanliness after muscular work resulting in soreness. They are useful when the irritability of the person is increased or when one has insomnia. Very hot baths of 100 degrees F. produce a reflex resembling the effect of cold baths. The enervating effect is manifested by a lower irritability or indisposition for muscular work. It may be overcome by a cold dash.

A bath at the body temperature produces very slight effect. It has a calming effect and is used in the treatment of the insane. It is best for weak individuals or where cleanliness is the object of the bath.

Prolonged bathing may produce the following ill effects, namely, nausea, faintness, giddiness, weakness, dyspnoea, and a subnormal temperature.

CLOTHING

Clothing is worn both for purposes of modesty and to maintain a constant body temperature. In this connection it must be borne in mind that the skin is the most important organ in temperature regulation. Clothing aids in protection from the effects of a lowered temperature by holding warm air enmeshed

(insulation), so that the body lives in a temperate climate, and also by influencing conduction, convection and evaporation.

Heat losses by conduction are favored by clothing made of plant fibers, since these conduct heat outwards better, although heat losses by this means are relatively slight. Furthermore the extent of the loss is reduced by the air enmeshed in the fabric, which factor is however greater in fabrics made from animal fibers, since their elasticity is less affected by laundering.

Heat losses by conduction are favored by anything which permits the warm air close to the body to be blown away. The degree to which this occurs is influenced by the porosity of the clothing. Of fabrics, flannel is the most porous and silk the least. Leather, paper and rubber prevent heat losses by this means.

If the spaces in the fabric be filled with water, the losses by evaporation as well as by conduction are increased. Thus wet clothes may chill the skin, and the cessation of exercise while the clothing is wet may be dangerous. Wool has the greatest hygroscopic power of all fabrics, so that water evaporates slowly from it. An ideal fabric would permit sweat to evaporate when poured out and would not stay wet when sweating ceases, or do away with the enmeshed air when wet.

The fabrics which make the most suitable clothing to be worn next to the skin in summer and warm climates are cotton or close meshed linen. For cold climates and for individuals who get little exercise wool is best. There are differences of opinion concerning those best adapted to individuals likely to get wet. Some advocate wool, for it absorbs sweat and still enmeshes air. Others object to it as it does not permit quick heat losses and dries slowly. Others favor cotton, especially coarse meshed fabrics, for permitting a quick heat loss. Objections raised to it are the fact that it wets through rapidly and no air spaces are left, while the heat losses may be too rapid.

Outer clothing in the summer is worn chiefly for appearances. It should be as permeable as possible and for this purpose cotton or linen are best. In winter woolen is the fabric of choice. If one is in the wind, impermeable goods should be selected. If a person lives mainly indoors in the winter the outer clothing need be the only change of adaptation. If one exercises in the cold do not make any change except to leave off the outer clothing while exercising.

The color of clothing has no effect on the radiation of the heat. Those colors which reflect the most heat absorb the least.

CHAPTER XXXIV

DOMESTIC SANITATION

The sanitation of the home does not present any features that distinguish it from other problems of sanitation. Rather it is the application of principles we have discussed in detail elsewhere in their particular relationship to the home. Therefore we cannot expect to find that very much new material will be presented at this time.

LOCATION

Other things being equal, an elevated well drained situation is preferable for the location of a dwelling. The importance of this factor is probably not so great as was considered at one time, but nevertheless should not be ignored. Poorly drained locations will permit accumulations of water close to dwellings and hence result in mosquito breeding, the contamination of wells is made more likely and in an effort to fill or raise the ground level, poor filling material is apt to be used, so that rat harbourage on the premises is favored.

CONSTRUCTION

The various materials from which dwellings are constructed are about equally valuable from a hygienic standpoint. In other words it is possible to construct dwellings of equal hygienic value from wood, brick, stone, concrete, or any other material. An important point in construction, regardless of the materials used, is to make the dwelling rodent proof. This is largely a matter of neat and careful workmenship, especially in the case of frame dwellings in which special precautions must be observed. The building must fit its foundation closely and all spaces between the floors and walls sealed tightly with brick or cement through which rodents cannot gnaw. This can be done by filling the spaces between the studdings above the sills for a distance of six or eight inches with mortar or bricks. Likewise the openings in the basement floors, and walls, as well as the basement ceilings through which pass conduits, drain pipes,

water, and gas pipes etc., should be tightly sealed with cement or flashed with tin. Knot holes should be tightly sealed with sheet tin. The provision of smooth, tight floors is likewise an important matter in promoting the future cleanliness of the dwelling, since less labor is required in keeping such floors clean than those which are rough and have large cracks.

LIGHTING

Every dwelling should be so situated that at some time of the day each of the sides will receive the sun's rays. Little can be said in favor of the type of dwelling construction common in large cities, where for blocks dwellings or tenements occupy the entire lot space, only presenting free wall space at the front and rear. The interior rooms of such dwellings receive very little natural illumination. The type of construction we earlier recommended is best, for first it permits full advantage to be taken of the brightly diffused sunlight for the illumination of the dwelling's interior during the day, and second, each room for some period of the day will have a greater or less amount of direct sunlight gaining entrance, and thus be benefited by its germicidal activity. Furthermore as we shall presently see, such construction enables the fullest advantage to be taken of natural ventilation.

Narrow streets and high dwellings, particularly those of the apartment or tenement variety, restrict the amount of sunlight available to adjacent buildings as well as to the street. Accordingly provision should be made to regulate the heighth of buildings in proportion to the width of the street they face. No interior rooms should be occupied as living, sleeping or working rooms, which do not have outside windows.

Large windows permitting the introduction of the maximum of sunlight and fresh air are desirable. Attention should be paid to the location of the windows on opposite sides of the dwelling, as well as the location of intermediate doors and windows, so that free passage of air across the house can be secured when the windows are open.

Artificial illumination is of course necessary for nights and dark days. Various methods are now available, from the candle, kerosene, gasoline, or acetylene lamps to gas and electricity. Electricity is probably the best when available, since the fire danger is the least, it does not consume oxygen from the air and the most brilliant illumination is possible.

The recent introduction of indirect illumination by means of light rays reflected upon the ceiling from concealed globes is undoubtedly the best means of artificial illumination. The room is lighted by a diffused glow, more nearly imitating natural illumination than any other means. Eye strain is avoided if those seated in the room so place themselves, or the lights are so situated, that the direct rays do not fall on the face. Those reading or doing work which requires close inspection should preferably seat themselves so that if right handed, the light falls over the left shoulder. Delicate work should be brightly illuminated by shaded lamps, in addition to those shedding a diffuse light over the apartment as a whole.

HEATING AND VENTILATION

These questions have already been discussed in detail. We shall only refer here to the attention which should be paid to the sleeping quarters when in use. Otherwise the stagnation of air in the breathing cone and the breathing zone will become very marked. Every provision should be made to permit the freest entrance of fresh air. The open air sleeping porches possess a distinct hygienic value. If asleep in a room the air of which is stagnant or sluggish, the concentration of the expired air in the breathing cone and the breathing zone reaches a maximum, due to the fact that an individuals relative position changes but slightly while at rest. The greater the motion of the air the less will be the stagnation of the air in these zones. Outdoor sleeping is of a distinct advantage in the prevention and treatment of tuberculosis. One may safely enjoy it at a temperature considerably below zero by providing sufficient bed covers and a hood.

OVERCROWDING

Hygienically there is little in the tenement or apartment house that is fundamentally sound. The ideal dwelling is a separate and distinct structure for the housing of each familial unit. The former are only economically justified by the high price of building land. Too often we find that expense in this connection leads to a reduction in the floor space of the apartment designed for only one family to the point where the occupants are constantly in each others society. Where rents are high this objectionable factor is intensified by the question of sub-leasing rooms to other individuals or families, as a conse-

quence of which the overcrowding is intensified. Thus it is not uncommon to find a single family with perhaps three or four children occupying only a single room or perhaps renting a portion of their altogether inadequate space to another individual or family. Under these conditions of over crowding, all ages and sexes must lead a life of the greatest intimacy; privacy is impossible and immoral acts or sexual precocity are stimulated. Adequate ventilation does not usually exist, opportunities for the transfer of human secretions and excretions reach a maximum and consequently contact transfer is always favored. A safe rule is to consider that each space occupied as a dwelling should provide at least one room for each member of the family, and not less than one room for each two individuals.

EXCRETA DISPOSAL

We will not consider this question from the standpoint considered previously. The prompt and regular elimination of the feces and urine bears an important relationship to health. Irregularity in these habits promotes constipation, and also the absorption of toxins from the fecal residue that impair health and mental efficiency. Consequently the education of an individual in the regular evacuation of the bowels, with most persons at least once daily, is of great importance. This is facilitated by providing a place for the evacuation of the bowels and bladder kept suitably clean and inoffensive, and where an individual is not exposed to extremes of temperature or inclement weather. The indoor closet must be regarded as a great improvement in domestic sanitation and one which has well nigh reached perfection. Any of the types of water flush closets on the market at present may be regarded as satisfactory. While the operation of these is dependent upon an abundant supply of running water, yet those whose homes are without running water can avail themselves of the convenience of indoor facilities for the discharge of the excreta. One of the best means for this purpose are the so-called chemical closets, in which the excreta are received in a pail or tank of caustic solution, which effects their disintegration and disinfection. These however are not automatic and require attention.

If neither of these means are available, the pit privy suitably located with regard to the water supply, must be regarded as the next best substitute. It should have a water tight pit or vault, and be of fly proof construction. Various types of

privies have been designed and have given varying degrees of satisfactory service. All that are water tight and fly tight will probably give satisfactory and safe service if properly attended, though some require frequent attention, especially the changing of the receptacles for the receipt of the excreta. Since such details are apt to be neglected and hence interfere with the satisfactory operation of the privy, the types recommended above are best as they require the least attention.

Isolated rural dwellings that have a supply of running water may enjoy the advantages of an indoor closet. The sewage may be received into a leaching cesspool or septic tank, preferably the latter, the overflow from which is disposed of by sub-surface irrigation. Such disposal methods must be carefully located with regard to the domestic water supply.

SCREENING

All doors and windows at least should be covered with a suitable screen. For this purpose brass, copper or galvanized wire netting, of at least 18 meshes to the inch, is preferable owing to its longer life. These should be carefully fitted and kept in repair. Fire places and chimneys must be scrutinized since it may be necessary to screen these. It is preferable to screen entire porches and galleries rather than the windows and doors opening out upon them. Before a house can be considered fly or mosquito tight it must be ascertained that no cracks or holes exist in the floors, walls or ceilings through which these insects can enter.

PERSONAL HYGIENE

Personal cleanliness bears a very close relationship to health as we have already seen. Facilities for its promotion should therefore be found in every home. It is perhaps made the easiest by means of running water and the large porcelain bath tubs and wash bowels now available. Lack of these facilities should however not deter one from frequent cleansing of the body, although the process is made less convenient by their absence.

THE KITCHEN

Two aspects of the kitchen demand our attention. The first of these is the care devoted to the temporary preservation of perishable food, either before or after cooking. Cold is the

means universally employed for this purpose. Where not employed bacterial decomposition may make certain food stuffs unsafe for consumption, especially milk for infant feeding. The employment of ice in insulated boxes or cabinets commonly known as refrigerators is very common. In the absence of ice, such food is sometimes suspended in wells, thereby jeopardizing both the food and the well, or similarly suspended in pits dug especially for this purpose. Such means will temporarily retard bacterial decomposition until the food is consumed. It must be borne in mind that the coldest situation in a refrigerator is below the ice. In the absence of these facilities, some advantage may be secured by placing the vessel obtaining the perishable food in another vessel which in turn is placed in a vessel containing water. Coarse cloths are placed over the inner vessel extending down into the water. The whole is then set in a position where air currents will cause the rapid evaporation of the water in the cloth, which rises by capillarity.

A second point is the disposal of the kitchen refuse or garbage. This should be carefully drained to free it from all water, and then wrapped in a paper before being placed in the garbage can. Or if a collecting service is not available, it may be burned in a coal or wood stove, buried, or fed to chickens or swine. It should never be deposited upon the surface of the ground close to the house, as it attracts flies and rats and the sour odor which develops during decomposition is very annoying. Toilet and washing facilities should be conveniently situated to the kitchen, especially where servants are employed.

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SECTION VII

DEMOGRAPHY

CHAPTER XXXV

STATISTICS OF POPULATION

1. **Demography** may be defined as the application of statistical methods to the study of populations. As such its scope is as broad as the activities of mankind. Our interest in it is exceedingly narrow, only relating to those statistics which indicate the changes and fluctuations of a population, as well as the degree of its health. This narrow field of demography is commonly designated as vital statistics. The subject of statistics may be defined as the numerical statement of facts for study and comparison, and the collection of data and its abstraction for generalization.

2. All studies in vital statistics are based upon the population of the area under consideration, and are necessarily expressed in terms of population. Statistics of population for the purposes of vital statistics must show the number of inhabitants of an area, classified by age, sex, nativity, race and occupation. More detailed information would be desirable but the labor of making more detailed analyses is commonly too great for the available funds.

This fundamental information regarding a population is obtained by a census enumeration. The standard census in the United States is conducted by the Federal Government. These have been taken every 10 years since 1790. In addition many states take decennial censuses at intervals mid-way between the years of the Federal census. In order to avoid omissions and errors it is desirable to take the censuses at a time of the year when the maximum number of individuals will be at their homes. The spring is considered the best time of the year for this purpose. Actually the census canvas requires several months for its accomplishment, yet for simplicity sake it can be, and is referred to a given date. Thus the 1910 census was referred to April 15th.

Of errors in census enumerations, the most important are the following: (1) Overlooked persons. It is not possible to require that the entire activities of a nation be suspended while the great inventory is being taken. Some individuals, especially those who are traveling are bound to be overlooked, others may be counted twice and unscrupulous enumerators or officials in charge of areas where a great civic pride in rapid population increases exists, all contribute their quota of error. On the

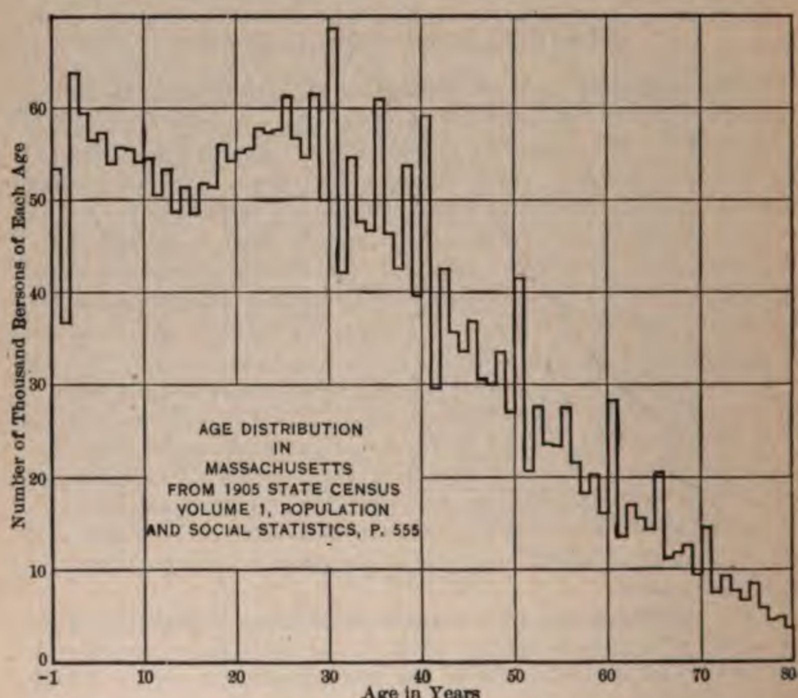

FIG. 119.—Age distribution in Massachusetts. (*Whipple, "Vital Statistics," John Wiley and Sons.*)

whole however, the Federal enumerations probably represent the most accurate enumeration possible, and the actual error is but a small fraction of one per cent. These censuses should always be taken as the standard. (2) A second common error results from misstatements regarding age. These are of two types. The age recorded should be the age of the individual at the last birthday. In the case of children up to five it is very common to find the stated age is really the age at the next

birthday. On the other hand adults show a tendency to express their age in round numbers, thus a person of 59 will give 60 as their age, or 60 for 62. As a consequence when the population is plotted according to age we find a great increase in the number of persons at each of these decennial ages over and above those at intermediate ages (Fig. 119).

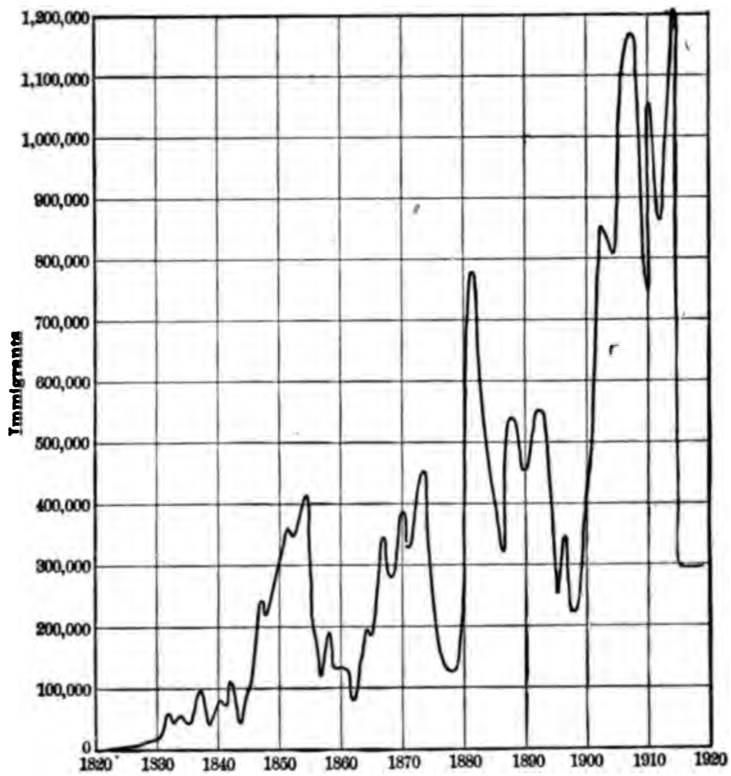

FIG. 120.—Immigration to the United States, 1820–1917. (*Whipple, "Vital Statistics," John Wiley and Sons.*)

Populations are never stable, continuous fluctuations is the rule either increasing or diminishing (Fig. 123). The most important as well as the most variable factor in these fluctuations are migrations, either a moving out (emigration) or a moving into an area (immigration) (Fig. 120). Migratory populations show a large relative proportion of adult males. As a result of these changes we may find that the entire charac-

ter of a population has changed, or its distribution within an area has been altered. Immigration is an important factor in territory under-going industrial development, while emigration is more commonly observed from areas of industrial stagnation or where competition is keen and sharp.

The other constant factors in population fluctuations are the increases resulting from births and the losses arising from deaths. Where the effect of migrations are not felt, a gradual increase is usually observable, the increments from births being usually in excess of the death losses (Fig. 121). On the other hand, in

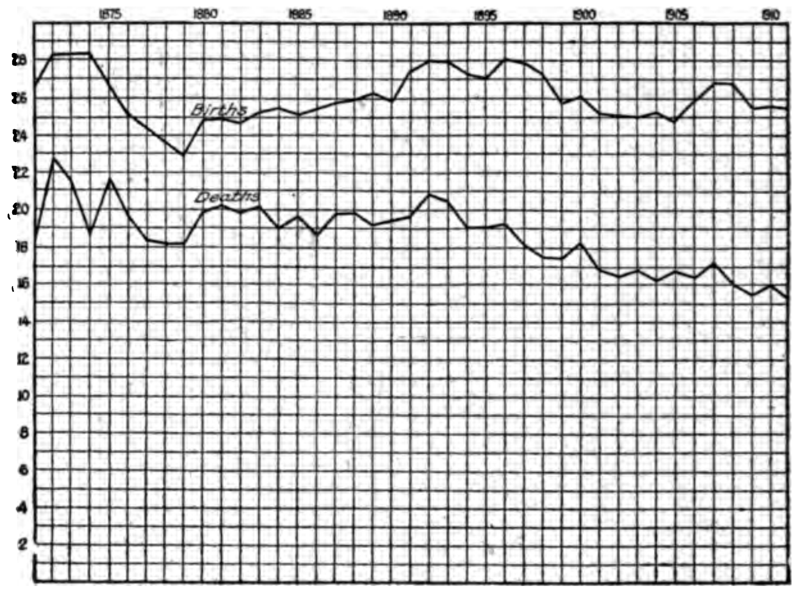

FIG. 121.—Births and deaths (exclusive of stillbirths) per 1,000 population per annum—Massachusetts—1871 to 1911. (*Trask: Suppl. 12, P. H. Rep.*)

some countries, such as France, the death rate may nearly coincide with, or at times exceed the birth rate (Fig. 122).

3. The great expense of census enumeration, as well as the time necessary for the analysis of the vast bulk of data secured prevent the performance of annual enumerations. Consequently where a population basis is required for the data of the intercensal years, estimates must be employed. For this two methods are available, the arithmetical and the geometrical.

(*a*) Arithmetical estimation: This method infers that a constant yearly increase in the number of the inhabitants has

taken place between the censal years and that the same increase will occur for some years following the last census. For employment, divide the difference between the population returns of the censuses by the number of years between them. Multiply the quotient by the number of desired years following the census and add the result to the proper census population. Thus supposing the population of an area was 64,410 in 1890 and 82,624 in 1900 and we desire to estimate the population in 1898 and 1904. Thus

Pop. 1900	82,624
Pop. 1890	64,410

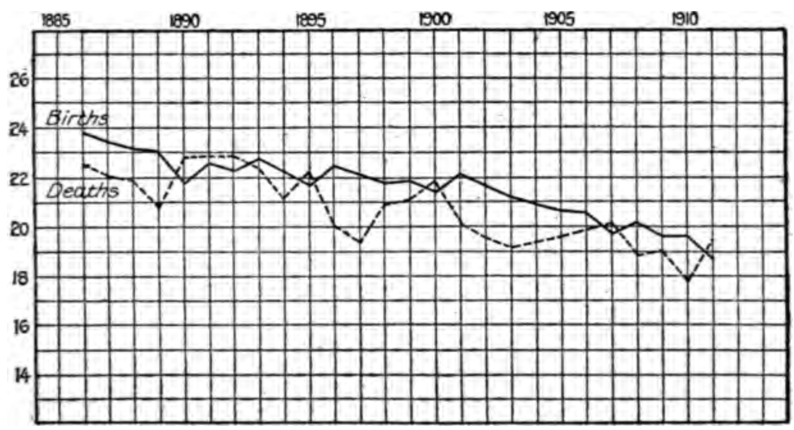

Fig. 122.—Births and deaths (exclusive of stillbirths) per 1,000 population per annum—France—1886 to 1911. (*Trask: Suppl. 12, P. H. Rep.*)

Increase 10 years—18,214 divided by 10 equals 1821.4 per year. For 1898 the population estimated would be 1821.4 times 8, equals 14,571 plus 64,410 equals 78,981. For 1904, the population estimates would be 1821.4 times 4 equals 7285 plus 82,624 equals 89,909. This of course assumes that no census figures for 1910 were available.

(*b*) The geometrical estimation assumes a constant rate of increase. For application the following formula is commonly used:

$$\text{Pn equals Pc}(1 \text{ plus r})\text{n}$$

$$\frac{\text{Pn}}{\text{Pc}} \text{ equals Pc}(1 \text{ plus r})\text{n}$$

For speed, logarithms are commonly employed for the solution of the second equation as follows:

log. Pn − log Pc equals n log (1 plus r)

Supposing that the 1900 census gave an area a population of 70,000 and the 1910 census 100,000 and we desire an estimate of the 1904 population. Thus according to our formula

Pn equals 100,000, whose log is 5.000
Pc equals 70,000, whose log is 4.851
5.000 − 4.8451 equals 0.1549

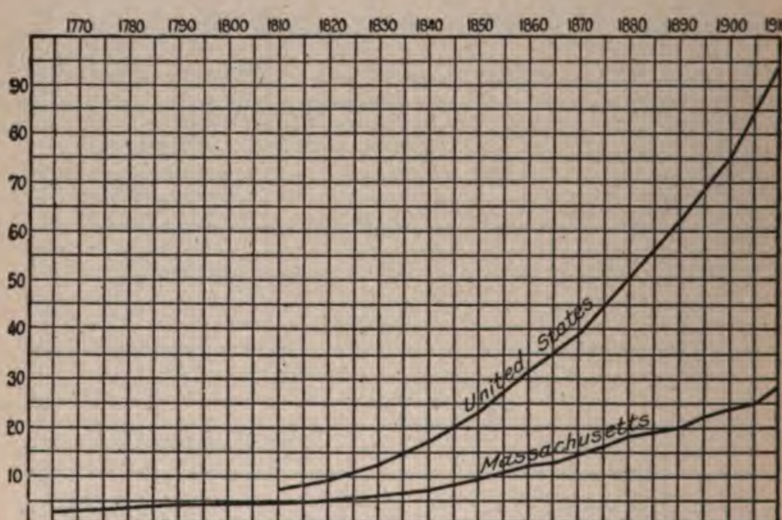

FIG. 123.—Population of the United States, in millions, 1810 to 1910; and of Massachusetts, in hundred thousands, 1765 to 1910. (*Trask, Suppl.* 12, *P. H. Rep.*)

0.1549 divided by 10 equals 0.01549, the log. of 1.036 or (1 plus r) of our formula.

0.01549 times 4 equals 0.062.

log. 0.062 plus log. 4.8451 equals 4.9071, which is the log of 80,750, the 1904 population.

Each of these methods is best adapted to populations presenting certain characteristics. The geometrical is best adapted to populations whose increase is due to the excess of births over deaths, while the arithmetical is best adapted to areas where growth is largely due to immigration. The latter is considered

best adapted for use in the United States. It is to be noted with these two methods, that in intercensal years the geometrical method will give results less than the arithmetical, but for postcensal years its results will be greater.

Where long time estimates are required, such as are required for planning the scope of public improvement for a long term of years, neither of these are reliable. It is better to compare the area with the development of other similar areas but of larger population, subsequent to the time when their populations were the same as that of the area under investigation.

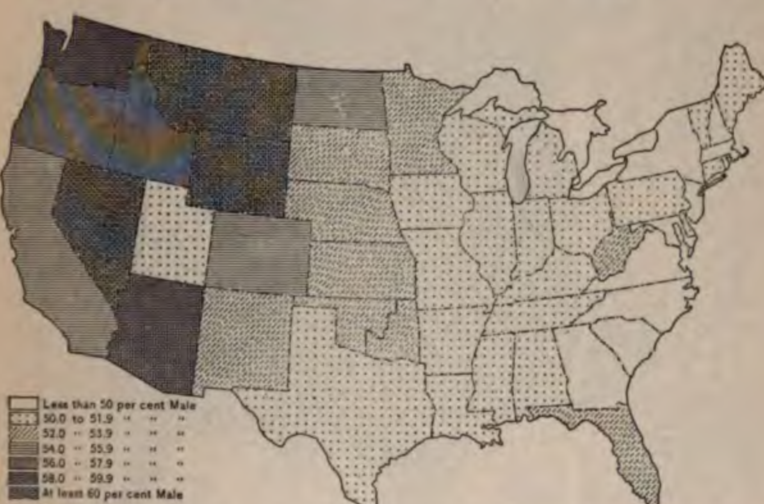

FIG. 124.—Per cent. male in total population for states and territories, 1900 (*Bull.* 14. *Bur. Census.*)

These methods are not always applicable, as for example, where a population shows stationary indications or has even declined at the last census. Less accurate methods of estimation only are available and these unfortunately are of no value in vital statistics. Thus we may estimate the population from the ratio of persons per dwelling, if the number of the latter are known. For the United States as a whole this is 5.2. A dwelling is defined as any building or set of rooms housing a family. Or the number of school children or trolley passengers may furnish a rough guide.

4. The commonest data tabulated from census returns relative to the composition of the population relates to sex, age, race

(Fig. 125) nationality and conjugal condition. Of these age, sex and race are the most important for use in vital statistics. Male births are in excess of female in proportion of 21:20, but male deaths are in excess of female deaths. The greater migratory habits of males leads to a diminution in the relative proportion of the sexes in older communities, so that females are in excess. Conversely in newly settled areas males will predominate (Fig. 124).

5. Another population distinction of importance from our standpoint relates to the distinction between urban and rural

FIG. 125.—Percentage negro in total population by states, 1910. (*Bull.* 129. *Bur. Census.*)

populations. Distinction is upon a purely arbitrary basis. Thus in the 1870 census towns of 8000 population or less were considered rural, in 1880, 4000 or less and in 1910, 2500 or less. Thus it can be seen that these distinctions have not been made on a constant basis. In the 1870 census 32.90 per cent. of the country's population was urban and in the 1880 census 37.3 per cent.

6. Another important point is the determination of the density of population, that is, the number of individuals per unit of surface area. Most commonly for larger areas such as states and countries the population is divided by the total area in miles or acres (Fig. 126). For comparative studies in an

urban population it is perhaps better to analyze data according to ward populations rather than by density per acre.

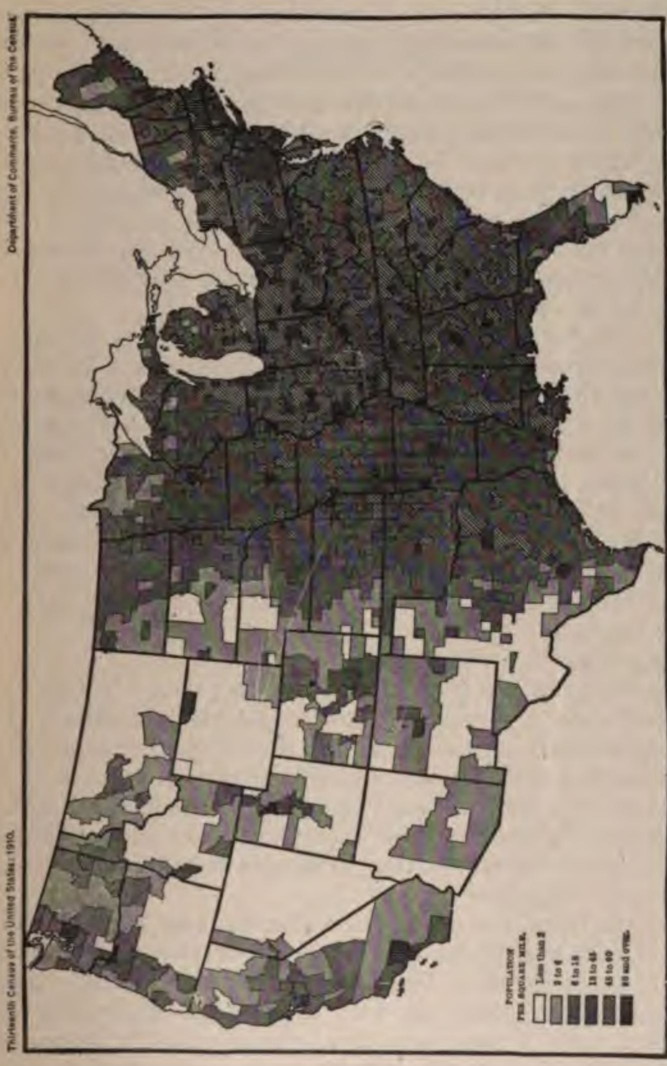

FIG. 126.—Population of the United States per square mile by counties, 1910. (*Whipple, "Vital Statistics," John Wiley and Sons.*)

In considering population fluctuations within civil areas in successive years it is important to ascertain if any changes have been made in the geographical boundaries of the area under con-

sideration. Large increases may be due to the annexation of territory with a considerable population, and sudden increases thus appear.

6. **Value of Vital Statistics.**—In any consideration of various facts concerning a large body of individuals, such as the population of a city, a state or a nation as regards births, deaths or individuals, it is impossible to consider the individual by himself, but rather all must be considered in the aggregate if any clear conception is to be gained of the influence of economic or morbific factors. Considered as individuals we would lose sight of the mass. As a consequence, it is necessary to employ statistical methods to avoid confusion and to enable the trend of events to be clearly discerned.

In any employment of statistical methods it is of course necessary to express facts by figures, and as expressed by Whipple: "When figures are used to express facts, and when logical processes are applied to figures, divorced in the mind from the facts for which they stand, it is easy for fallacies to creep in without being recognized; it is easy to compare things that ought not be compared; to generalize from inadequate data and so commit all sorts of illogical errors. Thus the unscrupulous may fool the unwary and the innocent fool themselves. Hence to use statistics properly one must be able not only to visualize the facts but to think logically."

Quoting Whipple further:

"Vital statistics are useful for many purposes. To the historian they show the nation's growth and mark the flood and ebb of physical life; to the economist they indicate the number and distribution of the producers and the consumers of wealth; to the sanitarian they measure the people's health and reflect the hygienic conditions of their environment; to the sociologist they show many things relating to human beings in their relations one with another."

"Vital statistics are not to be collected and used as mere records of past events; an even more important use is that of prophesying the future. The health officer should study them as soon as received and not wait until some convenient day when other work is slack and then merely tabulate them and make averages for formal reports and permanent records. Vital statistics, especially those of morbidity, should be studied in the making and just as the meteorologist reads his instruments daily in order to forecast the weather and give warnings of the coming hurricane, so the efficient health officer will daily study

the reports of new cases of disease in order that he may be forewarned of an impending epidemic and take measures to check its ravages."

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CHAPTER XXXVI

STATISTICS OF BIRTHS AND DEATHS

BIRTH STATISTICS

Birth records are secured by registration in those civil divisions that secure sufficiently complete records to be of value. Legal responsibility is placed upon physicians and mid-wives to make reasonably prompt returns in accordance with prescribed rules and upon special forms (Fig. 127), to designated officials. The securing of reasonably complete birth records is a difficult matter and at least in the United States is probably nowhere 100 per cent. complete.

Birth records are of value to individuals whose births are recorded from the standpoints of giving legal proof of citizenship, age and parentage, all of which are sometimes necessary to secure passports, residence, to secure employment, to prove legitimacy, to inherit property and in numerous other ways to enable an individual to enjoy the rights of citizenship. From a public health standpoint birth registration is of importance as it enables health authorities to intelligently combat infant mortality by means we have already considered.

All children who breathe after birth should be registered as births, while still births should not be recorded in either the groups of births or deaths, but placed in an independent group.

A rough check on the completeness of registration may be secured by comparing the total number of births registered by the number of children under 1 year of age enumerated in any census year.

The births in a given population may be expressed for comparative purposes in the following ways:

(*a*) The rate or number per 1000 of the entire population.

(*b*) The rate per 1000 women of child bearing age (15–45).

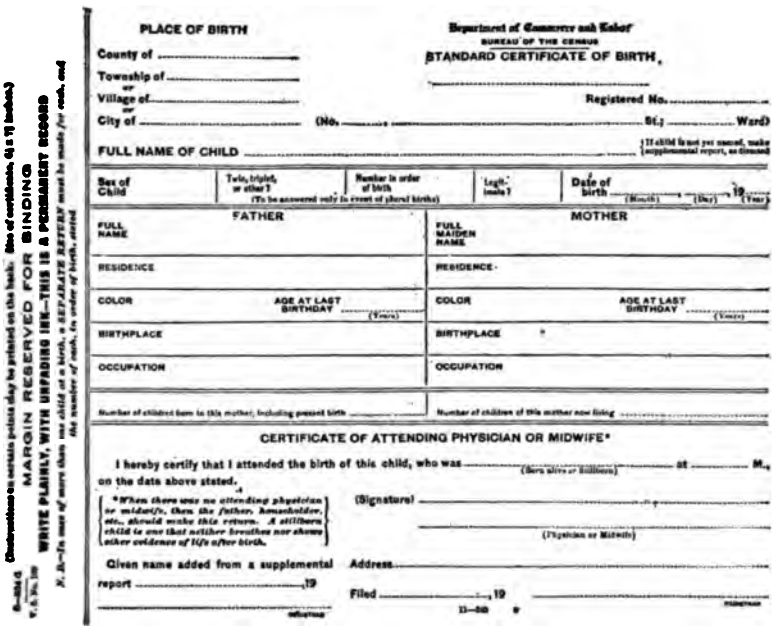
(*c*) The legitimate birth rate per 1000 married women of 15–45.

(*d*) The illegitimate birth rate per 1000 unmarried women of 15–45.

The first of these methods of expression is known as the crude birth rate, and *is subject to the same objections* when employed for comparative purposes that are raised to the crude death

rate. These will be considered later. These rates are computed in the same manner as the death rates, as shown later.

United States Standard Certificate of Birth.



MARGIN RESERVED FOR BINDING

WRITE PLAINLY, WITH UNFADING INK—THIS IS A PERMANENT RECORD

PLACE OF BIRTH

County of

Township of

or

Village of

or

City of (No. St.; Ward)

FULL NAME OF CHILD

STANDARD CERTIFICATE OF BIRTH

Registered No.

Sex of Child | Twin, triplet, or other? | Number in order of birth | Legitimate? | Date of birth (Month) (Day) (Year)

FATHER | MOTHER

FULL NAME | FULL MAIDEN NAME

RESIDENCE | RESIDENCE

COLOR | AGE AT LAST BIRTHDAY (Years) | COLOR | AGE AT LAST BIRTHDAY (Years)

BIRTHPLACE | BIRTHPLACE

OCCUPATION | OCCUPATION

CERTIFICATE OF ATTENDING PHYSICIAN OR MIDWIFE*

I hereby certify that I attended the birth of this child, who was ... at ... M., on the date above stated.

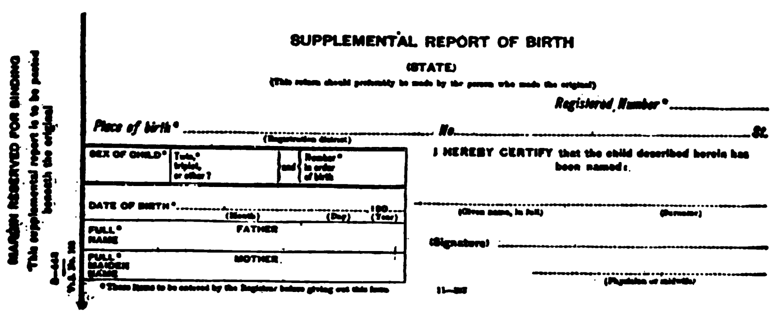
(Signature)

(Physician or Midwife)

Given name added from a supplemental report ..., 19

Address

Filed ..., 19



MARGIN RESERVED FOR BINDING

SUPPLEMENTAL REPORT OF BIRTH

(STATE)

Registered Number*

Place of birth* ... No. ... St.

SEX OF CHILD* | Twin,* triplet, or other? | Number* in order of birth

I HEREBY CERTIFY that the child described herein has been named:

DATE OF BIRTH* (Month) (Day) (Year)

(Given name, in full) (Surname)

FULL* NAME — FATHER

(Signature)

FULL* MAIDEN NAME — MOTHER

(Physician or midwife)

FIG. 127.—(*Trask, Suppl.* 12. *P. H. Rep.*)

The second method of expression gives a better idea of the fecundity of a population, while the third and fourth methods

when used together give a still better idea. These should be employed when it is desired to compare the births in one community with those of another.

The frequency of births varies widely with different races and nationalities, in different parts of a country, state or even a city. The crude rate may vary in the extreme from 22 to 39 per thousand. The following factors influence the birth rate: (*a*) the age distribution of the population; (*b*) the proportion of the two sexes; (*c*) the number of first marriages; (*d*) the age at marriage; (*e*) the economic condition of the country, and (*f*) social and hygienic conditions.

MORTALITY STATISTICS

Death records are likewise secured by registration. On the other hand, it is fairly easy to secure complete returns if a death certificate is required before a burial permit is issued. The death certificate (Fig. 128), a portion of which dealing with the cause of the death is filled out by the attending physician, is filed with the proper authorities by the undertaker.

Errors are not uncommon on these certificates and the authorities should require their correction before certificates are accepted. The original data may be incorrect, due to misstatements by members of the decedent's family. The statement of the cause of death given by the physician may be inaccurate due to an erroneous diagnosis or a desire to shield the feelings of the decedent's family.

One of the most important aspects of the physician's obligations in connection with mortality reporting is the statement concerning the cause or causes of death. Two grave errors are possible which seriously interfere with the accuracy of mortality returns. The first of these possible errors relates to mistakes in the diagnosis of the condition actually responsible for death. Any physician who has followed a considerable series of cases to postmortem is familiar with the fact that postmortem examinations not infrequently fail to corroborate the antemortem diagnosis, even when the patient had been under the care of extremely competent physicians. Where the postmortem examination serves as a check these errors are usually revealed, but where postmortem examinations are not made, and relatively few bodies are examined postmortem, these errors remain concealed. Another source of error is the employment by physicians of vague or inaccurate terms in stating

the cause of death, so that it is difficult to associate the stated cause with any definite pathological condition. The first of these possible errors can only be reduced by greater refinements in the art of diagnosis and of greater efficiency on the part of the medical profession in their application. The second can be reduced by care. The Census Bureau is endeavoring to secure an improvement in the last direction by familiarizing physicians with the standard International Lists of Causes of

MARGIN RESERVED FOR BINDING

N. B.—WRITE PLAINLY, WITH UNFADING INK—THIS IS A PERMANENT RECORD. Every item of information should be carefully supplied. AGE should be stated EXACTLY. PHYSICIANS should state CAUSE OF DEATH in plain terms, so that it may be properly classified. Exact statement of OCCUPATION is very important. See instructions on back of certificate.

STANDARD CERTIFICATE OF DEATH

DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS

1 PLACE OF DEATH
County ______ State ______ Registered No. ______
Township ______ or Village ______ or
City ______ No. ______ St., ______ Ward
(If death occurred in a hospital or institution, give its NAME instead of street and number)

2 FULL NAME ______
(a) Residence. No. ______ St., ______ Ward. ______
(Usual place of abode) (If nonresident give city or town and State)
Length of residence in city or town where death occurred yrs. mos. ds. How long in U. S., if of foreign birth? yrs. mos. ds.

PERSONAL AND STATISTICAL PARTICULARS

3 SEX | 4 COLOR OR RACE | 5 SINGLE, MARRIED, WIDOWED, OR DIVORCED (write the word)

5a If married, widowed, or divorced HUSBAND of (or) WIFE of

6 DATE OF BIRTH (month, day, and year)

7 AGE Years | Months | Days | If LESS than 1 day, ___ hrs. or ___ min.

8 OCCUPATION OF DECEASED
(a) Trade, profession, or particular kind of work ______
(b) General nature of industry, business, or establishment in which employed (or employer) ______
(c) Name of employer

9 BIRTHPLACE (city or town) ______
(State or country)

PARENTS
10 NAME OF FATHER
11 BIRTHPLACE OF FATHER (city or town) ______
(State or country)
12 MAIDEN NAME OF MOTHER
13 BIRTHPLACE OF MOTHER (city or town) ______
(State or country)

14 Informant ______
(Address)

15 Filed ______, 19 ______ REGISTRAR

MEDICAL CERTIFICATE OF DEATH

16 DATE OF DEATH (month, day, and year) 19

17 I HEREBY CERTIFY, That I attended deceased from ______, 19___ to ______, 19___,
that I last saw h___ alive on ______, 19___,
and that death occurred, on the date stated above, at ______m.
The CAUSE OF DEATH* was as follows:
______ (duration) ___ yrs. ___ mos. ___ ds.
CONTRIBUTORY ______
(Secondary)
______ (duration) ___ yrs. ___ mos. ___ ds.

18 Where was disease contracted if not at place of death? ______
Did an operation precede death? ______ Date of ______
Was there an autopsy? ______
What test confirmed diagnosis? ______
(Signed) ______, M. D.
, 19 (Address)

* State the DISEASE CAUSING DEATH, or in deaths from VIOLENT CAUSES, state (1) MEANS AND NATURE OF INJURY, and (2) whether ACCIDENTAL, SUICIDAL, or HOMICIDAL. (See reverse side for additional space.)

19 PLACE OF BURIAL, CREMATION, OR REMOVAL | DATE OF BURIAL 19

20 UNDERTAKER | ADDRESS

FIG. 128.

Death, and also the indefinite, objectionable terms whose use should be avoided. The Bureau publishes a very convenient pocket list of the proper terms.

Death records serve the following purposes; (*a*) they aid in the detection of crime, making the concealment of murders very difficult; (*b*) assist in the transfer of inherited property; (*c*) facilitate the settlement of life insurance, and lastly (*d*) indicate the extent and changes in population produced by death. From a public health standpoint they have some value in the

control of disease, especially where morbidity reporting does not exist. Their greatest drawback in this connection is due to the fact that the information they give is tardy and also

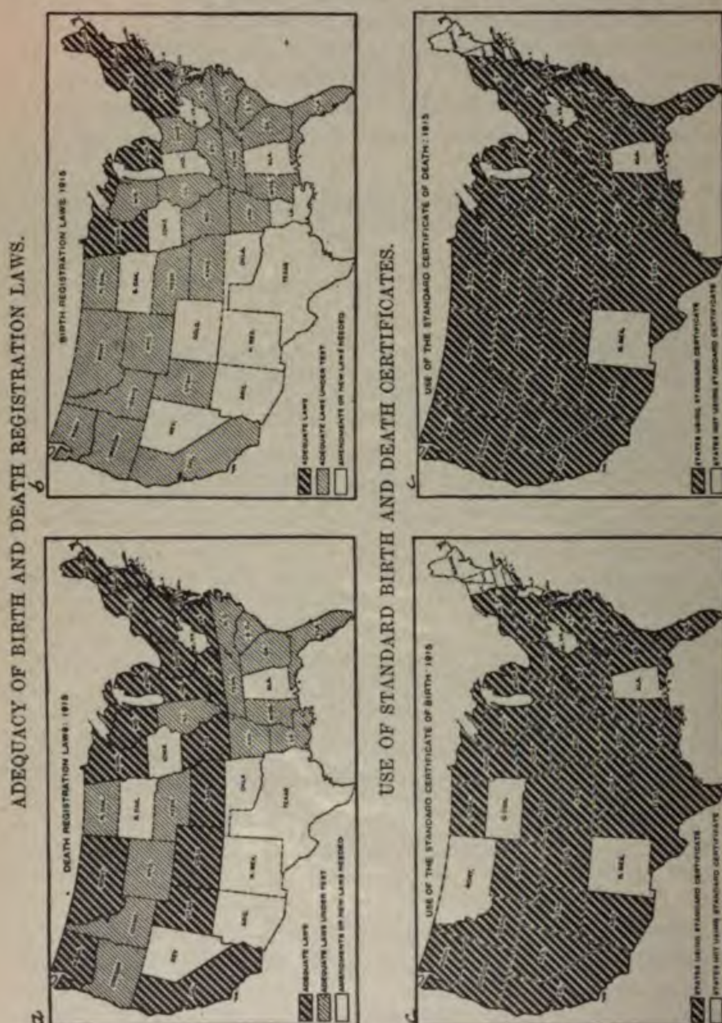


FIG. 129.—The states indicated as having adequate birth and death registration laws constitute the registration area. The interpretation is made by the Census Bureau. (*Wilbur: The Federal Registration Service of the United States. Bur. Census.*)

incomplete from the standpoint of revealing all disease incidence. A greater value they possess in this connection is in permitting a certain check to be made on the completeness of morbidity reports.

Deaths among a given population are expressed in rates fundamentally similar to those employed in expressing births. The most common rate employed is the general or crude death rate. This may be defined as the ratio of the number of deaths within a given time to the number of people alive at the middle of the period, referred to some round number (1000, 10,000 100,-

GENERAL DEATH RATES OF THE UNITED STATES (REGISTRATION AREA) AND CERTAIN FOREIGN COUNTRIES FOR EACH OF THE YEARS FROM 1900 TO 1914.

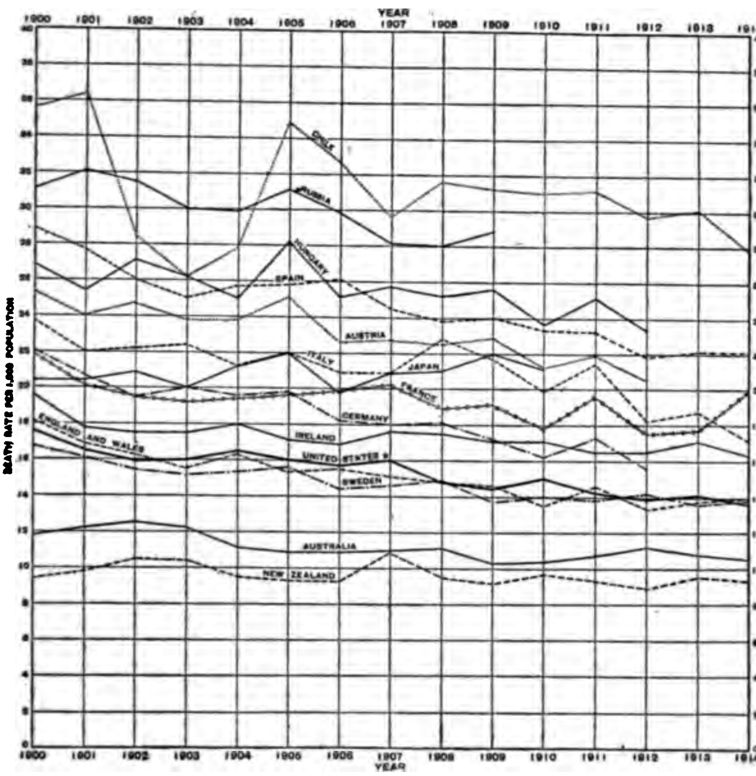


FIG. 130.—(*Mortality Statistics*, 1915, *Bur. Census.*)

000) as a basis for comparison. The period commonly chosen is one year. In estimating populations for this purpose it is necessary to estimate the mid-year population, making suitable corrections with the census figures for the dates to which they have been referred. Their precision depends upon the accuracy of the population and death figures.

They are computed as follows:

A population of 60,000 has in one year 900 deaths. What is the crude death rate per 1000?

Method A.

$$\frac{900}{60{,}000} \times 1000 = 15$$

Method B.

$$900 \div \frac{60{,}000}{1000} = 15$$

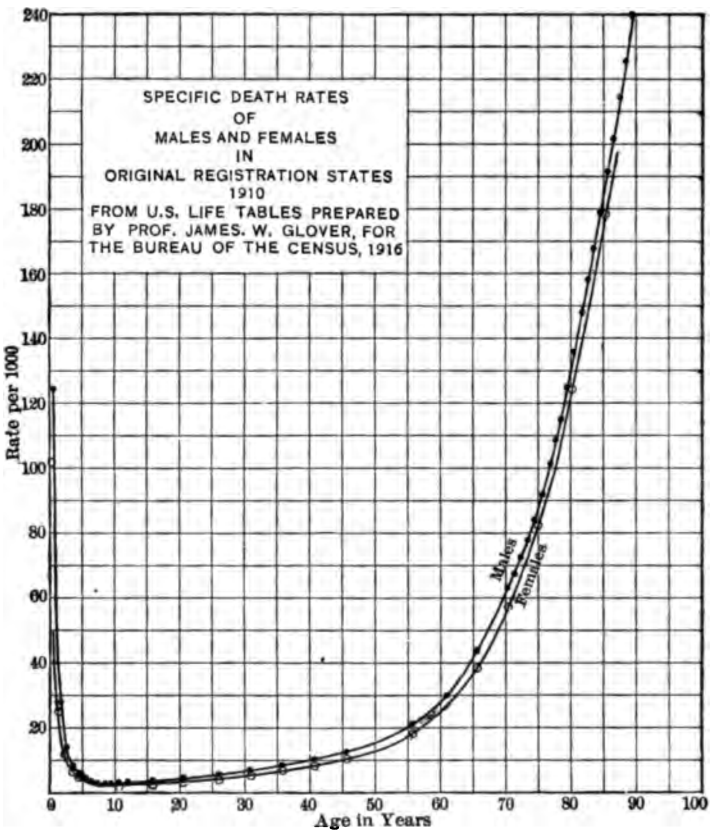


FIG. 131.—Specific death rates of males and females. (*Whipple, "Vital Statistics," John Wiley and Sons.*)

Their most common use is in a comparison of the mortality in the same community in different years, or between two com-

munities having similar populations. If the crude rate is employed in making comparisons between two communities having similar populations, falacious conclusions will almost certainly be drawn. For this purpose special rates should be employed of which we will shortly speak (Fig. 130.)

It is sometimes desirable to compute the death rates for short periods, such as weeks, months or quarters. When so computed these are expressed in terms of annual rates, *i.e.* as what the annual rate would be providing the deaths occurred throughout the year with the same frequency as during the week or month under consideration.

Another type of death rates frequently computed are the so-called specific rates. These are the rates for specific or limited groups of the population, such as those of age, sex, social condition, occupation, etc. They are stated as the proportion of the number of deaths per annum in the sub-group per 1000 of the mean annual number of the population in that sub-group. The groupings of age and occupation are most commonly employed (Fig. 131). The expression of births according to women of child bearing age may be considered a specific birth rate. They are the computations which should be employed for purposes of comparison or to secure a true insight into the prevalence or incidence of different diseases. Their computation can be readily understood from the following example. Divide the number of deaths of persons whose ages lie within the age groups employed, by the number of thousands of persons alive in the same groups at the mid-year. Thus:

TABLE XII

Boston Deaths by Age Periods for 1912

Age groups	Number of deaths	Estimated population in each age group	Specific death rate (1000)
Under 1	2,186 ÷	14,550	150.5
1–19	1,391 ÷	234,100	5.93
20–39	2,017 ÷	273,400	7.35
40–59	2,771 ÷	154,000	17.95
60 and over	3,274 ÷	47,400	68.8
Total	11,639 (total deaths)	724,175 (total population)	16.17 (crude)

A still better method to employ for comparative purposes is the standardized or corrected death rate. This is based upon a standard or stable population, not affected appreciably by migratory factors. The Swedish census of 1890 which had 5 age groups, or the standard million of England and Wales of 1901 with eleven age groups further subdivided according to sex, are most commonly used as a base. The standard Swedish population is divided per 1000 as follows:

Under 1	25.5
1–19	398.0
20–39	269.6
40–59	192.3
60 and over	114.6

The method is employed as follows: Compute the specific death rates of the several age groups of the population whose standardized death rate it is desired to obtain (Table XII). Then take the corresponding age groups in the standard population and compute the number of deaths that would have occurred in each age group at the specific death rate found to exist in the population for which the standard death rate is being computed. Add the number of deaths which it is thus found would have occurred in the age groups of the standard population. This gives the standardized rate per 1,000,000. The rate per 1,000 is secured by dividing this by 1,000.

We may exemplify this by continuing the employment of the Boston data already given.

TABLE XIII

Application of Corrected Death-rate, Boston, 1912

Age group	Specific death rate	Standard age distribution (Swedish)	Corrected death rate
Under 1	150.5 ×	25.5 ÷ 1,000	3.84
1–19	5.93 ×	398.0 ÷ 1,000	2.36
20–39	7.35 ×	269.6 ÷ 1,000	1.97
40–59	17.95 ×	192.3 ÷ 1,000	3.44
60 and over	68.8 ×	114.6 ÷ 1,000	7.84
	Corrected death rate		19.45

This is seen to be considerably higher than the crude death rate of 16.17 of our previous computation. Their value for comparative purposes is further shown in the following table:

	Cambridge, Mass.	Chicago
Crude death rate	15.2	14.5
Standardized death rate	14.5	16.4

With the employment of only the crude rate erroneous impressions might be drawn.

Death rates are influenced by the following factors: (*a*) Statistical methods employed in their computation. (*b*) The age, sex and social composition of the population. (*c*) The number and size of hospitals and institutions for the care of the sick and aged within the area. (*d*) Migration. (*e*) Hygienic and sanitary conditions. (*f*) The birth-rate.

INFANT MORTALITY

The expression of infant deaths is a difficult matter. Three methods are employed and each has disadvantages. They are as follows:

(*a*) As a ratio between the number of deaths under 1 year of age in 1 year, and the number of births within the same year, thus $\frac{\text{Deaths}}{\text{Births}}$. It is known as "Infant Mortality." Its inaccuracy lies in incomplete birth returns.

(*b*) As a ratio between the number of deaths in the calendar year under 1 year of age and the number of children under 1 year on July 1st of the calendar year. It is really the specific death rate, thus $\frac{\text{Deaths}}{\text{Infant population}}$. Its inaccuracy is likewise due to incomplete birth returns.

(*c*) As a ratio between the number of deaths under 1 year and the total deaths at all ages. This ratio is subject to fluctuations not related to infant mortality.

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CHAPTER XXXVII

STATISTICS OF SICKNESS

1. From the standpoint of public health, statistics of sickness or morbidity statistics are the vital statistics of greatest importance. These show the occurrence of disease and its relative prevalence in different localities and at different times.

This information is primarily secured by a system of reporting cases of illness known as notification. The responsibility for making these reports is primarily placed on the practicing physicians, and to a lesser extent on the householder or family head in the absence of an attending physician. Laws or regulations requiring these reports should specify that all real or suspected cases or carriers should be reported within 24 hours of their recognition or suspicion. Reports may be either by phone or mail, but the former method should always be confirmed in writing. As previously brought out, modern methods of disease control are based upon a prompt knowledge of how, when and where cases of preventable diseases are occurring. Consequently physicians in submitting their reports to health authorities are rendering a very important service in disease control

In this country the so-called model morbidity law now furnishes the basis for most reporting of this character. While adequate penalties should be provided for failure to make the necessary reports, yet health authorities will find it advantageous to make reporting as easy as possible for busy practitioners. One very helpful aid in this connection is the printing of report blanks on post cards and keeping the physicians adequately supplied with these (Fig. 132). The communicable diseases were the first group whose reporting was generally required, and in addition we frequently find the occupational diseases in these lists and sometimes cancer and pellagra. The following considerations should govern health authorities in selecting diseases to be placed upon the reportable list:

1. The disease should be one of public health importance either from the standpoint of causing death or disability.

2. It should be a disease whose means of prevention are fully understood and which may be effectively combatted, or

3. One for which highly effectively prophylactic or therapeutic agents exist. Thus cases of dog bites should be reported not because rabies spreads from man to man, but because prompt immunization will protect the person bitten from possible rabies in the biting animal.

4. If the disease is of itself trivial or unimportant, it may be indirectly of importance. Such as for example the confusion of chicken-pox with mild small-pox or German measles with scarlet

[Face of card.]

........................., 191..
(Date.)

Disease or suspected disease..............................
Patient's name.............., age.............., sex.............., color..............
Patient's address.............................., occupation..............................
School attended or place of employment..............................
Number in household: Adults.............................., children..............................
Probable source of infection or origin of disease..............................
If disease is smallpox, type.............................., number of times successfully vaccinated and approximate dates..............................
If typhoid fever, scarlet fever, diphtheria, or septic sore throat, was patient, or is any member of household engaged in the production or handling of milk..............................
Address of reporting physician..............................
Signature of physician..............................

[Reverse of card.]

For use of local health department.

.............................., 191..
(Date.)

Was case investigated by health department?..............................
Was nature of disease verified?..............................
What measures were taken to prevent the spread or the occurrence of additional cases from same origin?..............................

Health Department,
(City)..............
(State)..............

FIG. 132.—Standard morbidity report. (*Trask, Suppl. 12, P. H. Rep.*)

fever. These should therefore be reported so that a differential diagnosis may be made by experienced observers.

5. If an exotic disease, it should be one that could gain a permanent foothold if introduced. Thus yellow fever should be reportable in the gulf states where stegomyia mosquitoes abound, but no purpose is gained by placing yellow fever on the list of reportable diseases in Montana, where stegomyia is not found.

Notification in order to be of maximum value must be as

complete as possible. We have already called attention to unrecognized sources of infection which must be sought out by the initiative of the health authorities. Various checks are employed to indicate the degree with which physicians are discharging their notification duties. Thus all death certificates in which the ascribed cause is one of the reportable diseases should be compared with the morbidity report files to ascertain that the death was previously reported as a case. If not so previously reported, investigation will usually reveal that some one has been negligent. Case mortality ratios may also be used as a check. Thus from every death of typhoid reported, the morbidity files should reveal approximately ten reported cases of the disease. The reporting of the recognized cases by the physicians permits the health authorities to investigate the contacts for missed cases and carriers, and thus detect infected persons who would otherwise pass unrecognized and uncontrolled.

The data secured by these reports should be immediately classified and tabulated by the health authorities so that the maximum information will be revealed. They first of all should be classified according to disease. Each case reported should be located upon a spot map of the area. Summaries of the total cases of each disease reported by days, weeks or months should be kept constantly up to date, making the necessary additions to these tables each day. Thus the health authorities can constantly keep their fingers upon the pulse of disease prevalence and instantly recognize any epidemic in its incipiency and in addition deal effectively with endemic disease. Many health authorities in addition to the daily summaries above noted, also daily post the cases of diseases which may be milk-borne against the dealer from whom their milk was secured, and thus they can learn immediately of a milk-borne outbreak. If these reports are only used to prepare tables of figures to show past history of disease prevalence, very little actual service will result from reporting.

In general we may say that the morbidity information will be put to the following uses:

(*a*) It shows the geographical location of sources or foci of infection.

(*b*) Enables the health authorities, by the investigation of the cases reported, to secure epidemiological information of occurrence, distribution and prevalence of disease; ascertain missed cases and carriers and prevent the further spread of disease.

(*c*) Enables proper treatment to be provided for those financially unable to secure it.

(*d*) Indicates the necessary preventive measures.

(*e*) Gives the history of a given disease for a series of years, from which the endemic index may be computed.

(*f*) In the case of occupational diseases, it shows the location of conditions causing disease or injury.

For purposes of comparison morbidity information is expressed by several rates, as follows:

(*a*) The crude morbidity rate. This is the number of cases of a given disease occurring during a year per 1000 or 10,000 of the total population. This is open to the same disadvantages as crude rates in general.

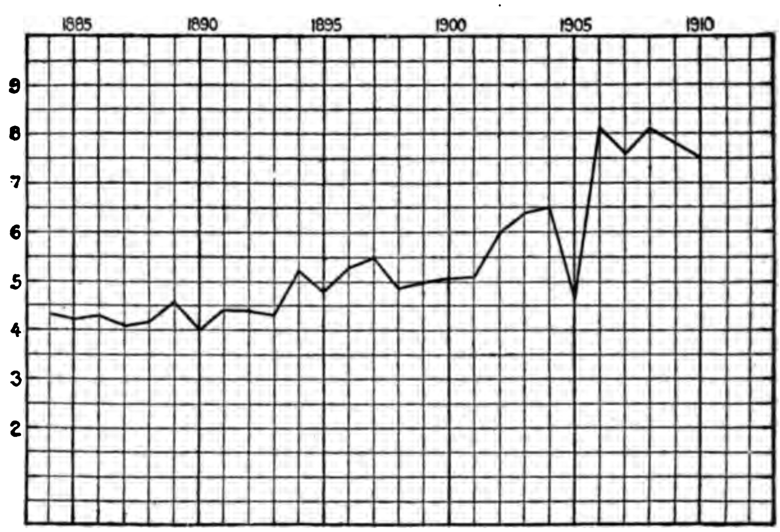

FIG. 133.—Diphtheria. Number of cases notified per annum for each death registered—Michigan—1884 to 1910 (*Trask, Suppl. 12., P. H. Rep.*).

(*b*) The specific morbidity rate. These are of a value similar to specific death rates. Diseases whose incidence is limited to certain age groups should also be expressed in rates of the number of cases per 1000 persons in the population of that age or class.

(*c*) Fatality rates. These may be expressed as the number of deaths per 100 cases or as the number of cases to each death. They are the same as the case mortality ratios previously noted. Owing to failures to report all cases they are usually too high (Figs. 133, 134)

For areas of small size with small or moderate populations,

small charts will enable the health authorities to keep in touch with the daily or weekly incidence of communicable diseases and detect epidemics in their incipiency. On the other hand, where a large number of geographical units must be supervised a more rapid method of ascertaining fluctuations of disease prevalence from the normal or endemic prevalence is afforded by comparison of the monthly summaries with the so-called endemic index of a disease for the area under consideration. This is the average monthly incidence of the reported cases of the disease in a given geographical unit, exclusive of cases rising

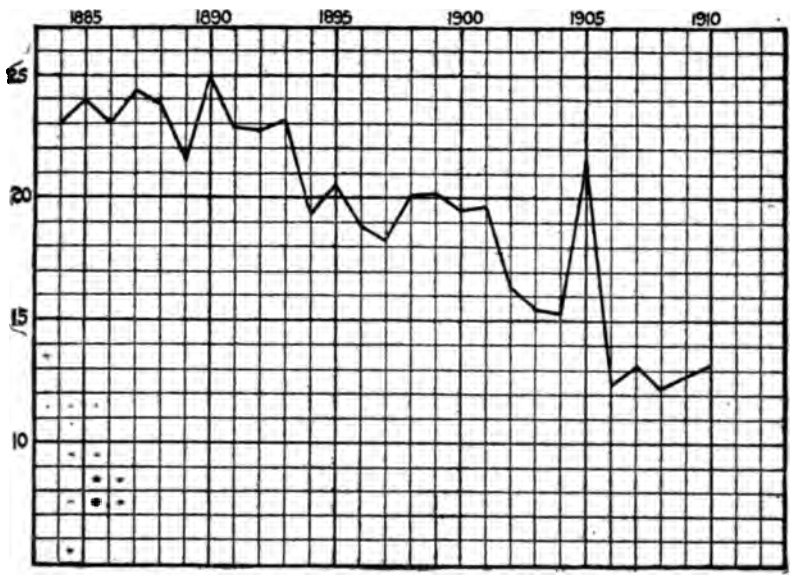

FIG. 134.—Diphtheria—Fatality rate (number of deaths registered per annum) per 100 notified cases)—Michigan—1884 to 1910 (*Trask, Suppl. 12., P. H. Rep.*).

in epidemics. Such standards of course require occasional revision. By their employment the beginning of an epidemic can be promptly noted.

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SECTION VIII

PUBLIC HEALTH

CHAPTER XXXVIII

PUBLIC HEALTH ADMINISTRATION

Public health administration in the United States is a function of the federal, state and local governments.

THE FEDERAL AGENCIES IN PUBLIC HEALTH WORK

The principal agency in this field is the Bureau of the Public Health Service of the Treasury Department, which has developed out of the old Marine Hospital Service. Other bureaus whose activities are related to public health are the following:

(*a*) Census Bureau, Department of Commerce. The Census; Statistics of Births and Deaths.

(*b*) Children's Bureau, Department of Labor. Child Hygiene and Maternal Hygiene.

(*c*) Bureau of Animal Industry, Department of Agriculture. Federal Meat Inspection.

(*d*) Bureau of Chemistry, Department of Agriculture. Food Inspection.

(*e*) Bureau of Biological Survey, Department of Agriculture. Coyote eradication (rabies).

(*f*) Department of Labor. Industrial Hygiene.

(*g*) Bureau of Mines, Department of Interior. Industrial Hygiene in the mining industries.

(*h*) Bureau of Education, Department of the Interior. School hygiene and sanitation.

The activities of the Public Health Service are more diverse, including control over interstate and international quarantine, supervision of the manufacture of biological products for human use, and inspection of immigrants. It also co-operates with States and Local Governments in epidemic control upon the invitation of the latter, and undertakes demonstrations of

practical sanitation, and conducts field and laboratory investigation into the public health problems of the United States.

It can thus be seen that there has been no systematic or co-ordinated plan in the development of our federal public health work. Effective work is being done, but there is much overlapping; departmental rivalry cannot stimulate economical or efficient work. There is great need for a co-ordination of all existing federal agencies, which probably can best be accomplished by their segregation into a single Public Health Department. Lack of more definite federal control is due to

FIG. 135.—A muster of steerage passengers. The boarding launch standing by ready for orders. (*Cofer, U. S. P. H. S.*)

the fact that all authority that the federal government possesses has been delegated by the individual states. The present trend of national policies seems to be towards a stronger central government. Where this will end, or what public health accomplishments will results cannot be accurately forecasted.

Before going further it might be well to briefly speak of the administration of maritime quarantine. All vessels either domestic or foreign which contemplate touching at an American port from abroad, are required to secure from the American Consul a document known as a bill of health. This is a statement of the health conditions aboard ship during her stay in

foreign ports, the number of passengers discharged, embarked, etc. Upon her arrival at an American port, the vessel first drops anchor at the quarantine station, where the boarding officer of the public health service receives the Bill of Health and examines the passengers, crew and vessel (Fig. 135). If no quarantinable diseases are found on board and the vessel has not come from a plague or yellow fever port, the boarding officer discharges the vessel from quarantine by the issuance of a certificate known as pratique. She is then free to proceed to her designated wharf or moorings. On the other hand, if any of the quarantinable diseases (cholera, yellow fever, plague, typhus, small-pox or leprosy) are found the passengers and crew are detained in quarantine for the period designated in the regulations, while their baggage and effects are fumigated. If the vessel comes from a plague or yellow fever port, the vessel is fumigated with sulphur dioxide or hydrocyanic acid to kill mosquitoes or rats. After these requirements are met pratique is granted.

STATE PUBLIC HEALTH ADMINISTRATION

Efficiency of organization and administration varies in different states, depending on their degree of progressiveness, freedom from political interference and the appropriations available. In Massachusetts, New York, Minnesota and a few others the organizations are highly efficient and developed along modern lines. In a few the state organizations practically exist on paper. The organizations in the remainder are manifestly inadequate. In these the state organization has evidently been particularly designed to exercise a loose supervision over, or an advisory capacity toward the local authorities, without possessing organization, staff, authority or appropriation enough to make the work efficient.

The different states really possess broad authority in matters pertaining to the public health under their constitutional police powers. A great impediment to the application of modern health methods is the fact that existing legislation is frequently based upon antiquated and erroneous ideas of preventable diseases and hence is of little value.

The administration of existing statutes in the different states is accomplished through the agency of State Boards or Departments of Health. In the former authority is centered in the Board and affairs move slowly. In the latter the head of the

department possesses the executive authority and prompt action is possible. An unfortunate phase of this situation is the fact that many of the appointments to these executive positions are not based upon training, experience, or other qualifications for public health work, but are given as rewards for political service. There is much opportunity for improvement in state health administration over the United States.

LOCAL HEALTH ADMINISTRATION

The units of local administration vary in different states, from counties to townships, cities and towns, the latter operating upon their charter authorizations. Authority is usually vested in a board of health, whose composition may be either of laymen or physicians, either elected or appointed. Their authority is delegated from the state. In operation it is usual to find that the administration of these local units is inefficient as well as inadequate. Consequently definite policies for the improvement of the public health or local sanitation based upon actual local needs are not formulated, and little or nothing is done to eradicate or reduce the preventable diseases of local importance. This difficulty is usually due to a popular apathy arising through ignorance of the importance of health matters and what may be done to remedy the evils. Consequently the local health administration is frequently in the hands of incompetent laymen or part time physicians, whose only qualifications are based upon proper political affiliations. At present, defective local health organization and administration is the weakest spot in public health protection.

The following may be suggested as remedies for this state of affairs:

(*a*) Popular education, *i.e.*, public health propaganda. Despite such efforts the public conscience can sometimes only be stimulated to the point where improvement is demanded as a result of a disastrous epidemic.

(*b*) Whole time public health officials with special professional or technical qualifications for the work. Success in this field requires the possession of an abundance of tact and diplomacy. Properly qualified whole time men should receive adequate remuneration.

(*c*) Adequate ordinance or regulations wisely and effectively enforced.

HEALTH OFFICERS

Health officers are usually the executive officers of the local board of health, whose duty it is to enforce the existing local regulations. Most commonly we find they have been recruited from the ranks of the local medical profession and give part time service. Their tenure of office is usually brief and their remuneration likewise slender. Public health work is now a distinct field, requiring special professional training. Medical training is of distinct value for public health work, probably more than that of any other profession if considered alone, but we must recognize that in itself it does not adequately qualify an individual for this field of work.

An appreciation of the importance of public health work is is rapidly spreading in the United States to-day-. As a consequence we shall rapidly see the old order of incompetency we have sketched pass away. The new order will demand improvement and require trained men to direct the work. Unusual opportunities now present themselves to trained men in this field.

HEALTH LAWS AND REGULATIONS

Drafts of proposed health legislation had best be carefully scanned by competent lawyers before enactment. Only laws that are capable of enforcement and whose constitutionality is above attack are of value. They must not exceed in their scope the authority delegated by the state to local administrative units. It must also be recognized that ability to secure their successful enforcement, particularly in those cases which require jury trials, depends upon the existence of a popular sentiment appreciating their necessity. Proper enacting and penalizing clauses should not be overlooked.

NUISANCES

Nuisances are what the name implies, both to the laymen and the health officer. Most conditions belonging to this category are not of public health importance, but a health officer may be bothered and annoyed by questions properly referable to police and peace officers for solution or abatement. From a public health standpoint the chief nuisances are grouped as follows: conditions favoring mosquito breeding (ponds, ditches, swamps, etc.,) rat harbourage (dumps, dilapidated buildings); fly breeding (manure piles, garbage); and excreta disposal

(dilapidated privies, full vaults etc.) From the standpoint of the public anything which is offensive to the senses constitutes a nuisance and many are the basis of legislation. A better definition is "The use of one's property in such a way as to injure the rights of others or to inflict damages." The abatement of nuisances may be accomplished through four different lines of procedure:

(*a*) by criminal action, (*b*) by injunction, (*c*) by suits for damages (private suit) and (*d*) by abatement under statutory powers.

PHYSICIAN'S DUTIES IN PUBLIC HEALTH WORK

A physician's responsibilities in public health work are of two kinds, his professional obligations which include the relationship between himself and his patients, and second, his legal obligations through responsibilities conferred by law.

The first group particularly includes the following responsibilities:

(*a*) Prompt and accurate diagnosis.

(*b*) Efficient treatment.

(*c*) Education of the patient and his family in simple hygiene and sanitation, and the enlistment of their co-operation in the cheerful and careful discharge of measures to prevent the further spread of a disease.

(*d*) Co-operation with the legal heaıth authorities.

His legal obligations include:

(*a*) Birth registration.

(*b*) Signing death certificates.

(*c*) Morbidity reporting.

PUBLIC HEALTH EDUCATION

Statutory enactments in the field of public health are not a panacea. Their purpose should be to secure uniformity of procedure, to provide means of coercing those who persist in trespassing on the rights of others and to centralize and define authority. Popular support is only given as the people see the necessity for protection and feel that the results desired can be secured.

Much more can be accomplished by the education of the public in matters of hygiene and sanitation, which will render compulsory enforcement unnecessary. It is a slow process and must be carefully developed. Avenues of instruction available

are through the press, the movies, pamphlets and circulars, lectures, special conferences and exhibits, and instruction in secondary schools. All information imparted should be fundamentally sound and one should avoid making dogmatic statements about debated points or unsettled questions. It is better to proceed slowly and safely than to later find it necessary to retract statements. Of the printed channels of communication the press is probably the best, since a large audience is reached. Articles for this purpose should be brief, to the point and written in simple language. Effective publicity work is quite an art and should receive considerable care and attention.

In the past the field of public health has been chiefly characterized by the growth and developement of the principles of sanitation, *i.e.*, of the care and attention that must be expended upon the environment of the human race. The greatest achievements have been realized in the control of the excreta and insect borne infective agents in those communities where their application has been undertaken. One is probably not greatly in error in declaring that in those communities the cultivation of this field has very nearly yielded its maximum fruitage. By this we do not intimate that a decline in the rated value or esteem of sanitation is to be expected, but that the diseases which may be considered at present to be a more or less unsolved problem in preventive medicine will be conquered by achievements in the field of personal hygiene. Needless to say the cultivation of this field may not be expected to yield as early a harvest as has sanitation. An enlightened policy on the part of public health officials, together with administration by trained sanitarians, in other words the activities of a few individuals, can secure all the benefits arising from adequate sanitation to a community, without the very active co-operation of the individual citizen. On the other hand, personal hygiene can only be effectively promoted through the aroused interest and education of each individual in the entire population concerned. This stage will arrive slowly and it may require the span of one or two generations before hygiene attains the position occupied by sanitation at the present time.

PHILANTHROPIC AGENCIES

An account of public health administration would not b complete without calling attention to the assistance given b private munificence. One of the most notable examples is th

offered by the Rockerfeller Foundation through the International Health Board. This organization is made possible by the income from funds provided by John D. Rockefeller and its work was originally directed at the world wide control of hookworm disease. This has later been extended to yellow fever and will probably later include malaria. This organization has not entered the field independently. Thus in the Southern United States it has co-operated with the different state boards of health, furnishing competent directors and a quota of the funds. The results that are following this work are of inestimable value. Another philanthropy working along somewhat different lines is the Russell Sage Foundation.

PUBLIC HEALTH NURSING

Successful work in disease control and prevention largely depends upon the degree of attention paid the individual human units of an area. The realization of this responsibility primarily arose in the out-clinic departments of some of the larger eastern hopitals. It was long realized that many patients ceased attendance at the clinics before being fully benefited by their treatment, or that bed patients following their discharge in a condition of distinct improvement, returned to home surroundings so unfavorable that the improvement laboriously achieved by the hospital was soon lost. Efforts were made to improve these conditions through the frequent visitation of patients in their homes, by urging the continuation of their clinic attendance, by instructing the responsible members of the family in their proper feeding and care, by providing the assistance of charitable agencies where such assistance was required. As a consequence the benefits of the hospitals have been greatly extended and their accomplishments afforded a greater degree of permanency. This type of service has been adopted by various health departments, for the most part securing the services of graduate nurses for this purpose. We have previously called attention to public health nursing in connection with maternity and child welfare clinics. A similar service can be rendered in the control of communicable diseases, through proper follow up care of patients discharged from isolation. Another variation of this type of service is afforded by the so-called visiting nurse, who makes periodical visits to the homes of those unable to provide hospital facilities or trained nursing, or where free hospital beds are not available, regardless of the character of the patient's illness. Instruction

is given the responsible members of the household in the proper feeding and care of the patient and in the execution of the physician's directions. The daily visits are continued as long as necessary to insure a continuation of the lessons given and to give further instruction. Thus in the public health nurse there has developed a distinct type in the social worker.

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